Volume 24, Number 6, March 31, 1970

NUCLEAR SCIENCE ABSTRACTS

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Personal Authors

Each author's name is indexed in the form appearing on the document abstracted:

ISHIHARA, T.
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ISHIHARA, Toyokuki
Shielding effect of paraffin, water, soil, concrete, Fe, and Pb for high-energy neutrons, 23:51748

Subjects

The subject index consisting of specific materials, objects, and processes is arranged alphabetically. Modifying phrases specific to these subjects in turn are arranged alphabetically under the subjects.

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Corporate Authors

Technical report literature is indexed from the name of the organization or institution responsible for the issuance of the report.

51093 (LA-4164) FABRICATION OF BORON CARBIDE RINGS AND DISKS. Sheinberg, H.; Herrera, T.; Kostacopoulos, J. (Los Alamos Scientific Lab., N. Mex.). Apr. 25, 1969. Contract W-7405-eng-36. 11p. Dep. CFSTI.

is indexed as:

LOS ALAMOS SCIENTIFIC LAB., N. MEX.
Fabrication of boron carbide rings and disks, 23:51093 (LA-4164)

Report Numbers

Technical report literature is also indexed by report numbers. This index includes information on where individual reports may be obtained. While not reports, patents and conference papers are indexed here as a matter of convenience.

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NUCLEAR SCIENCE ABSTRACTS

CHEMISTRY

Analytical Chemistry

Refer also to abstracts 9984, 9985, 10145, and 10155.

Chemical and Spectral Procedures

Refer also to abstract 9808.

9222 QUANTITATIVE PAPER AND THIN-LAYER CHROMATOGRAPHY. Shellard, E. J. London, Academic Press, 1968. 140p. 42s. 6d.

Among subjects discussed are: quantitative scanning of radioactive thin-layer chromatograms; bidimensional radiochromatogram scanning; and the evaluation of radiochromatograms using a spark chamber. (UK)

9223 DIRECT POTENTIOMETRIC DETERMINATION OF THE FORMAL POTENTIAL OF THE Bk(III)–Bk(IV) COUPLE IN SULPHURIC ACID. Stokely, J. R.; Bayborz, R. D.; Shults, W. D. (Oak Ridge National Lab., Tenn.). Inorg. Nucl. Chem. Lett.; 5: 877-84(Nov 1969).

Earlier work on this subject using tracer quantities of Bk, and indirect techniques, is briefly reviewed. The studies described employed direct potentiometry using microgram quantities. Sulfuric acid was chosen since the potential of the cerium couple in this medium is known (for comparison purposes), and because the stability of Bk(IV) toward reduction by water should be enhanced in sulphate medium, compared with other mineral acids, due to complexation. Potentiostatic electrolysis and potentiostatic coulometry were used to prepare solutions with known ratios of Bk(III) to Bk(IV), and the potentials of these solutions were measured with a separate platinum electrode. The formal potential could then be determined via the Nernst relationship. An estimate was also obtained of the radiolytic reduction rate of Bk(IV) from potential measurements. Results are tabulated and illustrated graphically. The studies suggested that chemical determination of Bk can be performed by potentiostatic coulometry, and that electrolytic oxidation is a convenient way of preparing Bk(IV) solutions. (UK)

9224 X-RAY FLUORESCENCE ANALYSIS OF MOLYBDENUM IN ORES, CONCENTRATES, AND SOLUTIONS. Jovanovic, Dobrinka (Inst. for Technology of Nuclear and Other Mineral Raw Materials, Belgrade). Tehnika (Belgrade); 24: 1080-5 (1969). (In Slovak).

A method of x-ray fluorescence analysis for the determination of molybdenum in ores, concentrates and solutions was developed. Strontium was used as the internal standard for the analysis of ores. The concentration of molybdenum ranging from 0.02 to 2.0% was investigated. For larger concentrations in ores and for concentrates dilution with SiO_2 was applied. In addition to this, the influence of the time of homogenizing the sample, of the internal standard and SiO_2 on the reproducibility of the results was investigated. The effect of copper and iron, the main components of the samples, on the intensity of K_1 molybdenum line was also investigated. The error of the determination for 0.80% of molybdenum ranged up to ±3%. The precision expressed by standard deviation was ±2.5% for 0.80% of molybdenum. For determining molybdenum in sulfuric acid solution, yttrium was used as internal standard. The concentration range from 0.2 to 4.0 mg of molybdenum per millitre was examined. The error of the determination for 2 mg of molybdenum per millitre was in the range ±2.5%. The time consumption for determining molybdenum in ores and in concentrates in two samples, was 1½ hour, and for determining molybdenum in solutions 50 minutes. (auth)

9225 SPECTROPHOTOMETRIC STUDY OF THE REACTION OF MOLYBDENUM WITH BENZOHYDROXAMIC AND SALICLOHYDROXAMIC ACIDS. Alimarin, I. P.; Borzenkova, N. P. Vestn. Mosk. Univ., Ser. II. Khim.; No. 5, 65-9(Sep-Oct 1969). (In Russian).

The reaction of molybdenum(VI) with benzohydroxamic(I) and salicylohydroxamic(II) acids in aqueous solutions was studied. The colored molybdenum complexes formed upon the interaction were found suitable for photometric determination of molybdenum. The molar extinction coefficients of molybdenum complexes with (I) and (II) were determined to be 86,000 (λ_{max} = 290 nm) and 12,000 (λ_{max} = 350 nm), respectively. (auth)

9226 ON THE EXTRACTIVE–PHOTOMETRIC DETERMINATION OF SCANDIUM WITH O,O'-DIOXYAZO COMPOUNDS. Alimarin, I. P.; Pigaga, A. K.; Gibalo, I. M. Vestn. Mosk. Univ., Ser. II. Khim.; No. 5, 94-5(Sep-Oct 1969). (In Russian).

Five O,O'-dioxyazo compounds were studied as reagents for the extractive–photometric determination of scandium: eriochrome black T, eriochrome Blue Black R, lumomagneson, lumogallion and magneson IREA, the latter being the best. The complex formed in the ratio Sc : R = 1 : 1 could be well extracted by higher alcohols, methyl–propyl ketone, and tributyl phosphate. Extraction from the aqueous phase by diethyl ester at pH 4.6 and by isoamyl acetate at pH 8.4 could be used for the extractive–photometric determination of scandium. The optical density should be measured at λ = 520 nm (ε = 15,000) and λ = 550 nm, respectively. (auth)

9227 DETERMINATION OF TIN IN ZIRCALOY BY GAS CHROMATOGRAPHY. Becker, H. J.; Chevallier, J.; Spitz, J. (CEN, Grenoble, France). Z. Anal. Chem.; 247: 301-5(26 Nov 1969). (In German).

The quantitative determination of tin in zirconium–tin alloys (Zircaloy) is described. The metallic sample is submitted to a reaction with gaseous chlorine. After removing the zirconium tetrachloride and an excess of chlorine, the tin tetrachloride is determined by gas chromatography. The accuracy of the method is comparable to that of the usual procedures. Thirty min are required for one determination. (auth)

9228 CALCIUM CARBOXYMETHYLDITHIOCARBAMATE AS AN AMPEROMETRIC REAGENT. Pavlichenko, V. A.; Usatenko, Yu. I.; Tulyupa, F. M. (Dnepropetrovsk Khim.-Tekhnol. Inst., USSR). Khim. Tekhnol.; No. 13, 88-91(1968). (In Russian).

The determination of Bi(III), Sb(III), Se(IV), and Te(IV) was based on the formation of soluble complex compounds with Ca carboxymethyldithiocarbamate (I), which is more stable in acid medium than is Na diethyldithiocarbamate. Bi(III) in low-melting alloys and Sb(III) in linotype alloys were determined after dissolution in HNO_3(Bi) or H_2SO_4(Sb) media. An aliquot was titrated with 0.01M I at 0.6 V vs S. C. E. Mn, Co, Ni, Zn, Pb, Cd, and Sn did not interfere. Hg, Cu, Te, Se, and Cl^- interfered. Se(IV) and Te(IV) are determined in HCl or H_2SO_4 media simultaneously by titration at pH 2.5 to 5.5 (Te) and at pH 2.0 (Te + Se). The determination of Se or Te in HCl was not affected by 100-fold excess of Bi or Sb. The error was −0.15 to +0.47%. (Selenium-Tellurium Abstr.)

9229 DETERMINATION OF MOLYBDENUM BY ALTERNATING-CURRENT POLAROGRAPHY. Vasileva, L. N.; Pozdnyakova,

A. A. Sb. Nauch. Tr., Gos. Nauch.-Issled. Inst. Tsvet. Metal.; No. 27, 44-9(1967). (In Russian).

Square-wave and vector polarography were used to study the behavior of Mo(VI) on a dropping-mercury electrode in a basal solution of 0.5 M-citric acid, 1 M-HNO_3, 2M-$HClO_4$, 0.5 M-tartaric acid, 0.5 M-oxalic acid, or 1 M-acetic acid (these media are in the order of decreasing sensitivity in the determination of Mo). The maximum reversibility of the reduction of the Mo (a one-electron process) was obtained in the citric acid basal solution. The peak height was proportional to the Mo concentration in the range 0.1 to 20 mg/l. The clearest peak was obtained at pH 1 (adjusted by adding up to 0.25% v/v of $HClO_4$). There was no interference from 1000-fold amounts of Pb, Cd, or Zn, a 200-fold amount of Fe, or a 30-fold amount of Cu. In the presence of larger amounts of Cu or Fe, the Mo is first coprecipitated with V by benzoin α-oxime. In the presence of a >10-fold excess of W the Mo peak is distorted because of adsorption of WO_4^{2-}. A procedure is given for determining Mo in ores and flotation tails. (Referativnyi Zh.)

9230 ANALYSIS OF ROTOR STEELS FOR RESIDUAL ELEMENTS. Byrne, F. P.; Nadalin, R. J.; Penkrot, J.; Rudolph, J. S.; Wolfe, C. R. (Westinghouse Electric Corp., Pittsburgh). Amer. Soc. Test. Mater., Spec. Tech. Publ., No. 407, 237-50(1967).

The general methods for analysis of rotor steels for Sb, As, Sn, Pb, Bi, Se, Te, Al, and Cu at the 15 ppM level were evaluated. Chemical methods are in existence but are slow. Polarography, with some further development, would also provide usable techniques, which would be slow. The instrumental methods of optical emission, x-ray fluorescence, and atomic absorption do not yield adequate results upon direct application to the specimen. However, with suitable concentration techniques, these methods show promise for rapid analysis of rotor steels. A number of concentration techniques are discussed, and acid precipitation of the sulfides appears to be the best approach. Spark source mass spectrometry, while quite sensitive, is not yet developed to the point of supplying rapid, precise, and accurate quantitative analyses. (Selenium-Tellurium Abstr.)

9231 MEASUREMENT OF DEUTERIUM IN WATER BY THE FALLING DROP METHOD. Hallaba, E.; Abdel-Wahab, E.; Islam, A.; Hamza, M. (Atomic Energy Establishment, Cairo). Z. Anal. Chem.; 247: 283-7(26 Nov 1969).

The falling drop method for the isotopic analysis of water sample is fully described. The optimum parameters of the ultra thermostat, the micropipet, the drop size, and the dropping medium for maximum accuracy are discussed. The o-fluorotoluene used should be of the highest purity elsewhere non-reproducible results are obtained. The accuracy obtained is 0.001% up to 0.096 mole % D_2O and 0.01% up to 0.994 mole % D_2O, although the relative accuracy is the same ±1.4% through the whole calibration curve and is comparable with that of mass spectrometry. (auth)

9232 QUANTITATIVE ANALYSIS FOR THE ISOTOPES OF HYDROGEN: H_2, HD, HT, D_2, DT, AND T_2-BY GAS CHROMATOGRAPHY. Genty, Claude; Schott, Roger (Centre d'Etudes de Bruyeres-le-Chatel, Montrouge, France). Anal. Chem.; 42: 7-11(Jan 1970).

Total separation of the six isotopic compounds of hydrogen (H_2, HD, HT, D_2, DT, and T_2) using a column filled with alumina covered by ferric hydroxide at 77°K was carried out. The conditions for good separation, symmetrical peaks, and short retention times were studied. After defining the column and, in particular, the treatment of the stationary phase which is made to undergo partial deactivation by carbon dioxide, quantitative analysis for the six compounds was perfected by using a double detection system consisting of a thermistor catharometer and an ionization chamber. The linearity ranges of these two detectors were defined. It was found that the use of the equilibrium constants: $H_2 + D_2 \rightleftharpoons 2$ HD, $D_2 + T_2 \rightleftharpoons 2$ DT, and $T_2 + H_2 \rightleftharpoons 2$ HT allows the determination of the isotopic ratios of a mixture of the six compounds by means of the ionization chamber alone. Besides, no calibration is needed for this analysis. The advantages of this method are compared with those of mass spectrometry. (auth)

9233 SPECTROPHOTOMETRIC DETERMINATION OF PHOSPHORUS AS AN IMPURITY IN NEODYMIUM AND YTTRIUM OXIDES OF HIGH PURITY. Alikina, N. A.; Barkovskii, V. F.; Shvarev, V. S. (Ural State Univ., Sverdlovsk, USSR). Zh. Anal. Khim.; 24: 1848-53(Dec 1969). (In Russian).

A reagent containing Mo(VI) and Mo(V) at a ratio of 3:2 was used for determining phosphorus in neodymium and yttrium oxides. The molar extinction coefficient is 25,000. Up to 200 μg of iron, 800 μg of copper, 20 μg of manganese, and 500 μg of silicon do not interfere with the phosphorus determination. The mean square error is not more than 4.5% at a phosphorus concentration of $n \cdot 10^{-4}$%

and at the weight of the oxide sample of 0.2 g. The possibility was shown of determining phosphorus by the formation of blue phosphomolybdic acid directly from phosphate, sodium molybdate, and molybdenum(V). Up to 200 μg of copper, 10 μg of silicon, 1700 μg of manganese, 800 μg of nickel, 20 μg of chromium (III and VI), 2000 μg of iron (II), and 200 μg of iron (III) do not interfere with phosphorus determination. The molar extinction coefficient is 26,000. The relative error of the method at a confidence level of 0.95 is 3.5%. (auth)

9234 EXTRACTION-PHOTOMETRIC DETERMINATION OF THE RARE EARTH ELEMENTS BY MEANS OF SALICYLIC ACID AND RHODAMINE S. Poluektov, N. S.; Sandu, M. A. (Inst. of General and Inorganic Chemistry, Odessa). Zh. Anal. Khim.; 24: 1828-32(Dec 1969). (In Russian).

The ions of the rare earth elements are capable of forming complex compounds with salicylic acid and Rhodamine S which can be extracted by benzene. The ratio of the components is Me : Sal : Rhod = 1 : 4 : 1. Photometric methods are suggested for determining lanthanum in the presence of yttrium which is masked by sodium fluoride, and for determining yttrium in the presence of lanthanum. This method is based on the capacity of sodium sulphate to decrease the colour intensity of the lanthanum complex to a greater degree as compared with the yttrium complex. The sensitivity of the methods is 0.5% of La_2O_3 in its mixture with Y_2O_3 and 0.3% of Y_2O_3 in its mixture with La_2O_3. (auth)

9235 DETERMINATION OF NIOBIUM WITH DISULFOPHENOL S AND SULFOCHLOROPHENOL S. Dobkina, B. M.; Dymova, M. S.; Nadezhdina, G. B. (State Scientific-Research and Design Inst. of Rare Metal Industry, Moscow. Central Scientific-Research Inst. of Ferrous Metallurgy, Moscow). Zh. Anal. Khim.; 1838-41(Dec 1969). (In Russian).

Analytical characteristics of disulfophenol S and sulfochlorophenol S and their complex compounds with niobium on the reaction in 1 to 3 N HCl were compared. The selectivity is higher in 3 N HCl. Methods were developed for the determination of niobium in ores and slags using disulfophenol S. (auth)

9236 X-RAY SPECTRAL DETERMINATION OF HIGH CONTENTS OF NIOBIUM AND TANTALUM. Donets, Yu. T. Zavod. Lab., 35: 1060-1(1969). (In Russian).

A method for the x-ray spectral determination of niobium and tantalum in minerals, industrial products, and concentrates is presented. In order to exclude the effect of coarseness and changes of gross composition, the material is floated from potassium pyrosulfate on the addition of an internal standard. An accuracy of 3% is obtained for samples containing >1% Nb and Ta. (tr-auth)

9237 X-RAY SPECTRAL DETERMINATION OF NIOBIUM AND TANTALUM IN EXTRACTION SOLUTIONS. Spitsyn, P. K.; Renev, V. K.; Antonov, A. V.; Troneva, N. V. Zavod. Lab., 35: 1061-2(1969). (In Russian).

A method for the x-ray fluorescence spectral determination of niobium and tantalum directly in solutions (the intermediate products of their extraction separation) was worked out. The time for the determination of one element is 3 to 5 minutes and the coefficient of variation is approximately 5%. (tr-auth)

9238 SPECTROGRAPHIC DETERMINATION OF RARE EARTH ELEMENTS IN THEIR BORIDES. Bel'tyukova, S. V.; Karpenko, L. I.; Fadeeva, L. A. (Odessa Inst. of General and Inorganic Chemistry). Zavod. Lab., 35: 1070-2(1969). (In Russian).

A method is given for the spark spectrum determination of rare earth elements (Ce, La) in solutions which contain boron. (tr-auth)

9239 POLAROGRAPHIC DETERMINATION OF Mo IN UO_2–SiO_2 VITROCERAMICS. Beleuta, I. L.; Bratu, C. (Inst. for Atomic Physics, Bucharest). Radiochem. Radioanal. Lett.; 2: 233-8(27 Dec 1969).

A method to determine Mo traces in UO_2-SiO_2 vitroceramics is presented. This material is obtained by melting a mixture of UO_2 and SiO_2 at 2300 to 2400°C in a Mo crucible. A connection between the amount of dissolved Mo and the H_2 pressure applied and the hyperstoichiometry was established. (auth)

9240 THE NEPTUNIUM(VII)–(VI) COUPLE IN SODIUM HYDROXIDE SOLUTIONS. Zielen, A. J.; Cohen, D. (Argonne National Lab., Ill.). J. Phys. Chem.; 74: 394-405(22 Jan 1970).

Controlled potential coulometry and conventional potentiometry established the existence of a reversible neptunium(VII)–(VI) couple in sodium hydroxide solutions. A study of the hydroxide ion dependence indicated the half-reaction to be $e^- + NpO_2^{2-} +$

$H_3O = NpO_2^{2-} + 2OH^-$. The formal potential of the couple in 1 M sodium hydroxide at 25° vs. the normal hydrogen electrode was determined to be 582.1 ± 0.45 mV. Electrolysis was found to be an excellent preparative method for both Np(VII) and Np(VI) in alkaline solution, and controlled potential coulometry can be directly applied as a quantitative analytical method for the Np(VII) content. Infrared absorption spectra of Np(VII) and Np(VI) in 1 M NaOH were determined; a single band at about 1100 cm^{-1} was found for both species. (auth)

9241 APPLICATION OF MICROWAVE SPECTROSCOPY TO THE ISOTOPIC ANALYSIS OF THE REACTION PRODUCTS OF METHYLACETYLENE WITH DEUTERIUM ON NICKEL CATALYSTS. Hirota, Kozo (Osaka Univ.); Yoshida, Noritetsu; Teratani, Shousuke; Saito, Shuji. J. Catal.; 15: 425-9(Dec 1969).

The reaction of methylacetylene with deuterium was investigated in a static system over nickel powders at 25°C, and the products were analyzed by mass spectroscopic and microwave spectroscopic methods. The propylene yield in the products was ca. 0.8, similar to the result presented in the literature. In sharp contrast with the reaction of propylene with deuterium, the methyl positions of propylene could not be deuterated, suggesting that the double-bond migration does not occur during the reaction. Of all the propylene-d_2, cis-dideuteropropylene consisted of more than half the product at the 70% conversion. Protium concentration on the surface was estimated to be very low during the reaction. This is in contrast to the situation in the reaction of olefins with deuterium. (auth)

9242 MICRODETERMINATION OF THORIUM AND ZIRCONIUM SEPARATELY AND IN THE PRESENCE OF EACH OTHER WITHOUT SEPARATING. Sinha, P. C.; Saxena, O. C. (Univ. of Allahabad, India). Microchem. J.; 14: 519-25(Dec 1969).

Thorium and zirconium were determined in micro amounts titrimetrically, separately, and in the presence of each other, with L-asparagine, using bromcresol green and xylenol orange as indicators. They form complexes with L-asparagine in the ratio of 1:4. The maximum error observed in the determination of thorium and zirconium was 2.0 and 1.8%, respectively. (auth)

Radiometric Procedures

Refer also to abstracts 9513, 9648, 9654, and 9665.

9243 (AERE-R-6203) THE DETERMINATION OF ^{44}Ti IN BREMSSTRAHLUNG IRRADIATED TITANIUM FOILS. McMillan, J. W.; Haynes, J. W.; Bentham, R. J.; Cunningham, J. D. (Atomic Energy Research Establishment, Harwell (England)). Oct 1969. 21p. Dep. CFSTI (U. S. Sales Only). UK 3s. 6d.

Pico-curie levels of ^{44}Ti were determined in large (5 g) titanium targets irradiated with bremsstrahlung of between 31 and 29 MeV. The titanium was separated from the principal interfering activities, ^{46}Sc, ^{47}Sc, and ^{48}Sc, by anion exchange in hydrofluoric–hydrochloric acid solutions. The ^{44}Sc in equilibrium with the separated ^{44}Ti was measured by gamma spectrometry using both Ge/Li and NaI detectors. The ^{44}Ti was determined with a precision of better than 5%. (auth) (UK)

9244 METHODOLOGICAL PRINCIPLES INVOLVED IN THE DETERMINATION OF THE ELEMENT RADIUM. Furnica, Gh. (Inst. of Hygiene, Bucharest). Stud. Cercet. Chim.; 17: 307-33 (Apr 1969). (In Rumanian).

The principles of the radiochemical separation of radium, its physicochemical and radiometric determination are described. Separation by coprecipitation with $BaSO_4$ may cause entrapment of up to 82% of the $PoSO_4$. The electrochromatographic method is based on the differences in the migration rates of the Ra^{2+}, Pb^{2+}, Bi^{3+}, and Po^{4+} ions. With ion exchangers, such as Dowex, the radium may be separated by elution from Th, Ac, Bi, and Po. Coprecipitation of $RaSO_4$ with $PbSO_4$ presents the same disadvantages as $BaSO_4$. Complexing with EDTA interferes with the ability of various elements to precipitate out with the SO_4^{2-} ion, depending on the pH of the solution, making it possible to affect the separation. The formation of the large number of daughters of radium causes special problems. Absorption on gels and on organic colloids, and extraction processes were found to yield good results. Radiometric methods involve the use of α, β, and γ spectroscopy and study of radon release; the spectroscopic measurements allow the location of the radioactive equilibrium and the type of the daughter products to be estimated. (58 references). (TTT)

9245 THERMAL NEUTRON ACTIVATION ANALYSIS OF PARTICULATE MATTER IN SURFACE AIR OF THE CHICAGO METROPOLITAN AREA. ONE-MINUTE IRRADIATIONS. Brar, Sarmukh S. (Argonne National Lab., Ill.); Nelson, Donald M.; Kanabrocki, Eugene L.; Moore, Carl E.; Burnham, Carol D.; Hattori, Donald M. Environ. Sci. Technol.; 4: 50-4(Jan 1970).

A procedure is described for the simultaneous determination of aluminum, vanadium, manganese, sodium, chlorine, and bromine in surface air of the Chicago Metropolitan Area. The particulates (dust) in approximately 5 standard cubic meters of air were irradiated for one minute in a thermal neutron flux of approximately 2×10^{13} n per cm^2 per second, and the activated nuclides obtained were analyzed by means of their γ spectra. Samples were collected April 4, 1968, at 22 air-sampling stations: 20 at selected sites throughout the city of Chicago, one at Morton Grove, and one at Argonne, Ill. The following values, in micrograms per standard cubic meter of air, were obtained: Al (0.48 to 3.2), V (0.0022 to 0.12), Mn (0.10 to 0.90), Na (0.10 to 0.67), Cl (0.61 to 5.9), and Br (0.024 to 0.32). Evidence is given for the presence of calcium and/or sulfur in these samples. (auth)

9246 CHEMICAL ANALYSIS BASED ON ALPHA SCATTERING. Krivan, Viliam. Chem. Listy; 63: 961-79(Sep 1969). (In Slovak).

The method of determining elements present in a sample by scattering of alpha particles is reviewed (29 references, all in English). The physical basis of the method is explained and the method is described together with experimental conditions. Alpha spectra of a number of elements are shown and the advantages and disadvantages of the method are discussed. The pertinent nuclear properties of 16 heavy radionuclides that emit alpha particles are tabulated, including curium and californium isotopes, and a nomogram for use in analytical work is given. (TTT)

9247 TRACE DETERMINATION OF URANIUM IN BIOLOGICAL MATERIAL BY FISSION TRACK COUNTING. Carpenter, B. Stephen (National Bureau of Standards, Washington, D. C.); Cheek, Conrad H. Anal. Chem.; 42: 121-3(Jan 1970).

A sensitive and selective method for the determination of trace amounts of U in biological materials, such as blood, is described. Blood and blood plasma analyses were used to illustrate the reproducibility of the method. The method requires that the sample size be very small if a low-temperature asher is used. When very small fractions of the original weighed sample are irradiated, it is particularly important to establish that a representative sample has been selected for the analysis. The sensitivity and detection limit of the method are dependent upon the integrated flux being used. (P.C.H.)

9248 RADIOCHEMICAL DETERMINATION OF ^{35}S IN LARGE SAMPLES OF VEGETATION. Willis, Conrad P.; Olson, Dale G.; Sill, Claude W. (Atomic Energy Commission, Idaho Falls, Idaho). Anal. Chem.; 42: 124-6(Jan 1970).

A method is described for the determination of ^{35}S in green alfalfa by liquid scintillation counting. The method involves the decomposition of 30-g samples of alfalfa by wet-ashing with less than a 4% loss of the S. Twelve samples can be decomposed at a time by one operator in less than 2 hr. The counting efficiency for ^{35}S was estimated from a certified ^{14}C standard. An overall recovery of 93% or better was obtained routinely by means of this procedure. (P.C.H.)

9249 A SIMPLE METHOD FOR DETERMINATION OF FISSION GASES TRAPPED IN IRRADIATED FUEL FORMS. Sheibley, Dean W. (National Aeronautics and Space Administration, Sandusky, Ohio). Anal. Chem.; 42: 142-3(Jan 1970).

A method that combines the differential dissolution technique with trapping of released fission gases on activated charcoal at liquid nitrogen temperature is described for the determination of fission gases trapped in irradiated fuel forms. The hazard due to accumulation of hydrogen and oxygen generated from electrolysis of the solution is eliminated. The equipment used and the method of determining the gaseous activity by γ counting are described, and the method is evaluated. The accuracy of the method for determining ^{85}Kr activity including the counting error is ±2.5% (standard deviation) at 10^5 dpm. The range of ^{85}Kr activity that can be handled with the counting system described, and at the same accuracy, is 5 μCi to 100 mCi. However, it was not possible to assign an overall accuracy to the method. (P.C.H.)

9250 IDENTIFICATION AND DETERMINATION OF VARIOUS URANIUM FISSION PRODUCTS AFTER DETACHMENT FROM METAL SURFACES. II. Sorantin, H. (Oesterreichische Studiengesellschaft fuer Atomenergie GmbH, Seibersdorf, Austria). Mikrochim. Acta; 6: 1117-43(1969). (In German).

In order to establish approximate values for the solid fission products that would be expected to be formed during the operation of high temperature reactors in the primary cycle, test burner elements were irradiated in a cylindrical capsule made of special steel. Following the disassembling, parts of the inclosing

tube were cleaned off with acids in an apparatus devised for this purpose. In this way, the ^{131}I could be distilled over and the fission products detached in a single operation. Through directed decontamination steps and selected precipitation or extraction methods ^{140}Ba, ^{90}Sr, ^{95}Zr, ^{137}Cs, and ^{144}Ce were separated in the residual corrosion solution that contains an excess of activation products of the aluminum and graphite contaminants, the steel components, soldering materials, and thermoelement envelopes. By employing a Ge(Li)-detector and a 4000-canal impulse high analyzer it was possible to determine various radionuclides in the presence of each other, so that the chemical method of separation could be simplified through the saving of decontamination processes, and the activation products ^{46}Sc, ^{51}Cr, ^{54}Mn, ^{58}Co, ^{59}Fe, ^{65}Zn, ^{110m}Ag, and ^{182}Ta could be identified. The determination of ^{90}Sr was accomplished via its daughter ^{90}Y following removal of ^{89}Y by liquid scintillation. (auth)

9251 IMPROVEMENT IN ENRICHMENT PROCEDURE FOR ANALYSIS OF TRITIUM IN NATURAL WATER. II. Takahashi, Tan; Nishida, Masami; Hamada, Tatsuji (Inst. of Physical and Chemical Research, Saitama, Japan). Radioisotopes (Tokyo); 18: 559(Dec 1969).

In order to obtain good constancy in the separation factor of tritium, large cells were constructed of nickel. Electrolysis was carried out and the sample value reduced from 1000 to 500 ml to about 100 ml. The separation factor was found to be 5.41. (M.C.G.)

9252 TRITIUM CONCENTRATION IN WINE, RAIN, AND GROUND WATER. Takahashi, Tan; Nishida, Masami; Ohno, Shigeru; Hamada, Tatsuji (Inst. of Physical and Chemical Research, Saitama, Japan). Radioisotopes (Tokyo); 18: 560-3 (Dec 1969).

Tritium was concentrated in the samples by electrolysis in nickel cells. The enriched samples were neutralized, reduced to hydrogen, and the tritium activity determined by counting. Data are given for wine, rain, and groundwater. (M.C.G.)

9253 RAPID DETERMINATION OF ^{99}Mo IN SEPARATED ^{99m}Tc. Richards, P.; O'Brien, M. J. (Brookhaven National Lab., Upton, N. Y.). J. Nucl. Med.; 10: 517(Jul 1969).

A rapid technique was developed for determining ^{99}Mo in separated ^{99m}Tc using a commercially available instrument. The detector is a pressurized ionization chamber with a center well for receiving samples. Response to the radiations from a number of commonly used radionuclides is adjusted electronically to give a direct reading in activity. It is possible to take two readings in the instrument, one shielded and one unshielded, and from predetermined data to readily derive the ^{99}Mo present in a known amount of ^{99m}Tc. (M.C.G.)

Activation Procedures

Refer also to abstracts 9511, 9522, 9523, 9649, 9730, 9736, 9737, and 9873.

9254 SIMPLE NEUTRON ACTIVATION METHOD FOR MERCURY IN BIOLOGICAL MATERIAL. Johansen, O.; Steinnes, E. (Instituut for Atomenergi, Kjeller, Norway). Int. J. Appl. Radiat. Isotop.; 20: 751-5(Nov 1969).

A simple radiochemical neutron activation method based on 65-hr ^{197}Hg is described. After decomposition of the irradiated samples with a NHO_3/H_2SO_4 mixture, mercury is isolated by sulfide precipitation at pH 8 to 9. The chemical yield is higher than 98%. A number of elements accompany mercury in the separation, but in most biological samples, none of their radioisotopes interferes seriously in the determination if the mercury content is higher than 0.01 ppM. (auth)(UK)

9255 PROCESS AND APPARATUS FOR ANALYSIS OF NEUTRON ACTIVATION OF AN ELEMENT IN LIQUID SAMPLES. Comar, Dominique; LePoec, Claude (to Commissariat a l'Energie Atomique). U. S. Patent 3,479,508. 18 Nov 1969. Priority date 22 Apr 1965, France.

In neutron activation analysis the radioactivity of a halogen element present in samples is determined by a separate extraction of a halogen element from each irradiated sample. A volume of the extracted halogen element is accumulated and moved into a loop. A counter adjacent the loop measures the activity of the sample while in the loop and thereafter the next accumulated sample passes through the loop and the preceding sample is discharged. (Offic. Gaz.)

9256 DETERMINATION OF SMALL AMOUNTS OF CADMIUM IN URANIUM OXIDE BY NEUTRON-ACTIVATION ANALYSIS. Ruf, Heinz (Kernforschungszentrum, Karlsruhe, Ger.). Z. Anal. Chem.; 247: 297-301(26 Nov 1969). (In German).

A pre-separation of cadmium from uranium by anion-exchange on Dowex-1 was followed by irradiation on the exchange resin in the FR-2. The cadmium activities produced could be obtained radiochemically pure by a short chemical separation procedure after irradiation. After correction of the chemical yields the activities were proportional to the original cadmium content. Ten ppB to 5 ppM of Cd could be determined. (auth)

9257 VAPORIZED AMOUNTS, VAPORIZATION BEHAVIOR, AND SPECTRAL LINE INTENSITY OF GADOLINIUM IN GRAPHITE POWDER BY ARC DISCHARGE. Osawa, Hisao (Fuji Electric Co., Yokosuka, Japan). Bunseki Kiki; 7: 748-55(Nov 1969). (In Japanese).

The relations between the vaporized amounts, vaporization behavior, and spectral line intensity of Gd in graphite powder, and dc arc discharge conditions were examined with graphite electrodes. Standard samples were prepared with highly purified graphite powder, 1000 ppM of Gd as Gd_2O_3 and various concentration of LiF as a spectrographic buffer substance. A dc arc technique was used for exciting the element, and the neutron activation analysis technique was used for measuring the concentration of Gd in graphite powder after arc discharge. The vaporized amounts and vaporization behavior depended mostly on the electrode temperature. As an arc current increased, the vaporized amounts increased and the temperature of anode was raised. Under the experimental conditions including dc 9.9 amp, 12.5 V, exposure time 60 sec, electrode gap 3 mm, and 2.0% of LiF in Ar atmosphere, the vaporized amounts from mg sample were 3×10^{-7} g at anode crater and 2×10^{-7} g at cathode crater. The emission line intensity of Gd depended on the vaporized amounts of Gd in Ar atmosphere. Under the experimental conditions the observed temperature range of the arc column was 2800 to 3600°K, and its correlation with the concentration of LiF was not linear. The arc column temperature was calculated by the equation; $\log(I_A/I_g) = -5040\ E/T + C$. (NSA of Japan)

9258 ACTIVATION ANALYSIS OF CONTAMINANTS IN PROCESSING AGENTS USED IN THE TELECOMMUNICATION INDUSTRY. Csada, I.; Schneer, A.; Rausch, H. KFKI (Kozp. Fiz. Kut. Intez.) Kozlem.; 16: 219-23(1968). (In Hungarian).

Methods are described, which were developed for the determination of trace elements occurring as contaminants in silicochloroform, distilled water, HNO_3, and carbon tetrachloride. The activated contaminants are identified and determined by paper-chromatographic separation and γ spectrometry. The elements that could be determined in this way are As, Sb, Cr, Au, Na in silicochloroform, Cu, Na, Mn, As in distilled water, Cu and Na in HNO_3, Cu, Mn, Na in carbon tetrachloride. (Hung. Tech. Abstr.)

9259 PAPER CHROMATOGRAPHY SEPARATION IN NEUTRON ACTIVATION ANALYSIS. Schneer, A. E. Kem. Kozlem.; 31: No. 1, 23-30(1969). (In Hungarian).

A paper chromatographic separation can be applied to inactive trace contaminants in the range of 10^{-10} g/g, which are detected by their reactions with active compounds or elementary particles. The various activation methods are described and a literature survey of the methods and apparatuses for the detection of labeled compounds is presented. The activated contaminants of semiconductor purity Si were separated by paper chromatography, and the presence of Au, Cu, Ni, and Co was demonstrated. The paper chromatographic method is suitable for the detection of about 50 metal ions and for the separation of some of them and can be successfully applied in neutron activation analysis. The applicability of the method to the analysis of $SiHCl_3$ and of reactor water is demonstrated. The spectrometric analysis of neutron-irradiated and paper-chromatographically separated components is an excellent method for the determination of contaminants. (Hung. Tech. Abstr.)

9260 INVESTIGATIONS ON THE ORIGIN AND QUANTITY OF EXOGENOUS INCLUSIONS IN STEEL BY MEANS OF NONRADIOACTIVE TRACERS AND ACTIVATION ANALYSIS. Rewienska-Kosciukova, B.; Wezranowski, E.; Zarzecka, E.; Radwan, M., Paluchowicz, L. (Inst. of Nuclear Research, Warsaw). Hutnik; 34: 576-80(1967). (In Polish).

A method is described for the determination of nonmetallic inclusions in steels originating from refractory materials, such as the ladle lining for steel cast in vacuum or under normal conditions and from the hearth of electric furnaces either with or without the use of induction mixers. The choice of nonradioactive tracer elements and the preparation of refractory materials with the addition of substances containing tracer elements is described. The preparation of samples for neutron activation and γ-spectrometric

measurements with results and conclusions are presented. (NSA of Poland)

9261 ELIMINATION OF ^{24}Na AND ^{42}K INTERFERENCES IN ACTIVATION ANALYSIS OF BIOLOGICAL SAMPLES. Tang, Chung-wai; Maletskos, Constantine J. (Cancer Research Inst., Boston. New England Deaconess Hospital, Boston. Harvard Medical School, Boston). Science; 167: 52-4(2 Jan 1970).

A column technique was developed for the removal of sodium-24 and potassium-42 based on a heterogeneous isotopic exchange reaction between an organic eluting solution (acetone–hydrochloric acid) and fine crystals of sodium chloride or potassium chloride or their analogs. The technique is fast, efficient, and highly selective; it was successfully applied to irradiated human tissues prior to gamma spectrometry with lithium-drifted germanium detectors. (auth)

9262 NEUTRON ACTIVATION ANALYSIS: TITANIUM AND LEAD DETERMINATIONS IN HIGH PURITY ALUMINIUM AND IRON. Samadi, A. A.; May, S. Bull. Soc. Chim. Fr.; No. 10, 3776-84(Oct 1969). (In French).

The determination of Ti and Pb in high-purity Al and Fe is based on radioactivation with fast neutrons using a high flux reactor. The sensitivity for the determination of Ti using the nuclear reaction $^{47}Ti(n,p)^{47}Sc$ is about 10^{-9} g. In industrial iron samples the amount of Ti is of the order of 10^{-6} g and in purified samples the amount of Ti varies from 0.2 to <0.01 ppM according to the sampling. Amounts between 2 and <0.01 ppM of Ti were found in Al. The analysis shows a good reproducibility in results. For Pb analysis the nuclear reaction $^{204}Pb(n,2n)^{203}Pb$ is used. The sensitivity is of the order of 5.10^{-9} g. Chemical separation processes are given. (auth)

9263 DETERMINATION OF VANADIUM IN NATURAL WATERS BY NEUTRON ACTIVATION ANALYSIS. Linstedt, K. Daniel; Kruger, Paul (Stanford Univ., Calif.). Anal. Chem.; 42: 113-15(Jan 1970).

The occurrence and behavior of V in several natural waters has been investigated as part of a study of the fate of this element in domestic supply waters. A generally applicable procedure has been developed for quantitative analyses of dissolved V in natural waters. This procedure includes a rapid pre-irradiation concentration to enhance the sensitivity of analysis with low flux reactors, and a post-irradiation radiochemical separation to reduce the interference of other radionuclides. The V concentrations ranged from a low value of 0.2 μg/l to a high value of 49.2 μg/l. None of the samples analyzed had a concentration below the 0.1 μg/l sensitivity limit of the method for 1-liter samples. Data are tabulated. (P.C.H.)

9264 SELECTION OF AN ANALYTICAL TECHNIQUE FOR INSTRUMENTAL ACTIVATION ANALYSIS, UNDER CONSIDERATION OF THE SENSITIVITY AND STATISTICAL ACCURACY OF THE MEASUREMENTS. Egiazarov, B. G.; Zyubko, V. A.; Selyutin, R. P. At. Energ. (USSR); 27: 460-2(Nov 1969). (In Russian).

Formulas developed in earlier computer studies for optimizing the time of irradiation on the basis of the activity ratio of the isotopes in the mixture were found to lead often to erroneous results; therefore, they were further improved by taking into account the accuracy and sensitivity of the measurements. The equations obtained make it possible to determine also the most economical, rather than the optimum, conditions of the analyses, as it is often desirable to keep the overall irradiation, cooling and measurement period to a minimum, or to determine the lowest flux that still allows carrying out the intended determination. The formulas may be used also to determine the lowest measurable concentration of an element in the mixture or to calculate the experimental conditions to be used at another beamhole. As an example, the calculations needed for determining the impurities present in a high-purity molybdenum specimen are presented for a fast-neutron flux of 10^9 n/cm²/sec. (TTT)

9265 DETERMINATION OF SELENIUM IN EYE-LENSES BY NEUTRON ACTIVATION ANALYSIS USING /sup 77m/Se. Filby, R. H.; Yakeley, W. L. (Washington State Univ., Pullman). Radiochem. Radioanal. Lett.; 2: 307-1(27 Dec 1969).

A method is described for the determination of selenium in the eye-lenses of dogs as part of a study on cataract growth. (auth)

Inorganic, Organic, and Physical Chemistry

Refer also to abstracts 9225, 9240, 9349, 9355, 9387, 9388, 9397, 9400, 9402, 9403, 9411, 9412, 9435, 9448, 9458, 9472, 9473, 10182, 10612, 10613, 10623, 11153, 11212, and 11215.

9266 (AERE-R-6217) DISSOLUTION OF PLUTONIUM DIOXIDE IN HYDROCHLORIC ACID AT HIGH TEMPERATURE AND PRESSURE. Crossley, D.; Milner, G. W. C. (Atomic Energy Research Establishment, Harwell (England)). Oct 1969. 15p. Dep. CFSTI (U. S. Sales Only). UK 3s. 6d.

A method is described for the dissolution of refractory plutonium dioxide in hydrochloric acid. It involves the transference of a weighed amount of sample to a silica tube, together with concentrated hydrochloric acid and an oxidizing acid if required. The tube is then sealed with an oxy-coal gas flame, and it is heated at 320°C in an autoclave which produces a compensating pressure of 4000 lb/in². A convenient arrangement for most specimens involves heating the tube overnight in the autoclave. The heating time needed for complete dissolution depends on the history of the plutonium dioxide, particularly the ignition temperature employed. The dissolution of plutonium dioxide fired at 1550°C, and also fused material, was achieved with this method. (auth) (UK)

9267 (ANL-7509) BIBLIOGRAPHY OF NOBLE GAS CHEMISTRY TO JULY 1, 1968. Hyman, Herbert H.; Chernick, Cedric L. (Argonne National Lab., Ill.). Oct 1968. Contract W-31-109-eng-38. 54p. Dep. CFSTI.

Abstracts are arranged by year (1962 through 1968) and for each year the entries are arranged alphabetically according to the name of the first author. (430 references). (D.H.M.)

9268 (ANL-Trans-792) CARBON MONOXIDE EQUILIBRIUM PRESSURE OVER URANIUM OXYCARBIDES IN THE PRESENCE OF URANIUM DIOXIDE. Bazin, J.; Accary, A. Translated for Argonne National Lab., Ill., from Bull. Soc. Fr. Ceram.; No. 79, 109-16(1968). 14p. Dep. CFSTI.

Supersedes abstract in NSA, 23: 17424.

Studies showed that when UC is in the presence of UO_2, a chemical equilibrium exists, which produces carboxides. These carboxides are increasingly richer in oxygen as the reaction progresses, while the equilibrium pressure of the CO formed decreases with the oxygen content of the carboxide. The reaction stops when the carboxide reaches its maximum oxygen content as a function of temperature and pressure, or when the UO_2 has been completely consumed. (auth)

9269 (CEA-R-3919) CONTRIBUTION TO THE STUDY OF ACTINIDE SULFIDES. Marcon, Jean-Pierre (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Nov 1969. 117p. (In French). Dep. CFSTI (U. S. Sales Only).

Thesis. Submitted to Univ. of Paris, Faculte des Sciences, France.

In the system plutonium–sulfur, the compounds PuS_2, $PuS_{1.9}$, Pu_2S_3 (α), Pu_2S_7 (β), Pu_3S_4 (γ) and PuS are described. The crystal structure of PuS_2 and $PuS_{1.9}$ was resolved, and the area of the diagram between Pu_2S_3 and Pu_3S_4 was particularly studied. Study of the systems neptunium–sulfur and uranium–plutonium–sulfur allowed the relation between different actinide sulfides to be explained. This analysis was proven by the existence of different valence states for every actinide sulfide, confirmed by the study of selenides and oxysulfides of plutonium. (auth)

9270 (COO-294-11) VISCOSITIES OF SOLUTIONS OF POTASSIUM IN LIQUID AMMONIA AND DEUTERO-AMMONIA. Hutchison, Clyde A. Jr.; O'Reilly, Donald E. (Chicago Univ., Ill.). 12 Nov 1969. 19p. Dep. CFSTI.

The viscosities of solutions of potassium in liquid ammonia and deutero-ammonia were measured with an Ostwald viscosimeter at –33.6°C, 0.0°C, and +20.0°C, over a concentration range from zero to approximately 1.5 mole/liter. The methods of measurement and the experimental results are given. The viscosities, η, of the pure liquids, measured in centipoise, are least squares fitted by the relations, $\log_e \eta = -4.677 + 1.577/RT$ for ammonia and $\log_e \eta = -4.676 + 1.670/RT$ for deutero-ammonia, in which R is the gas constant and T is the Kelvin temperature. (auth)

9271 (COO-1140-182) PROGRESS REPORT [ON HIGH TEMPERATURE CHEMISTRY], NOVEMBER 1, 1968–OCTOBER 31, 1969. (Kansas Univ., Lawrence). 31 Oct 1969. Contract AT(11-1)-1140. 25p. Dep. CFSTI.

Studies are in progress which are designed to resolve discrepancies in thermodynamic values for the vaporization of titanium oxides. Vaporization of gadolinium sulfide, dysprosium monosulfide, and yttrium monosulfide was studied. Isomolecular reactions were performed on eight binary rare earth sulfide systems. Progress in research on the kinetics of high temperature vaporization reactions is reported. (J.G.B.)

9272 (ORO-3518-13) ELECTROCHEMICAL STUDIES IN MOLTEN FLUORIDES AND OTHER HALIDES. Progress Report,

April 1, 1969–March 31, 1970. Mamantov, Gleb (Tennessee Univ., Knoxville. Dept. of Chemistry). Jan 1970. Contract AT(40-1)-3518. 9p. Dep. CFSTI.

Voltammetric studies on the lower oxidation states of thorium in the $LiF-ThF_4$ (73–27 mole %) melt in contact with metallic thorium have to date been unsuccessful because of the formation of a metallic surface film (possibly thorium) and the lack of wetting of the boron nitride sheath of the Ni/NiF_2 reference electrode. Studies on the use of solid LaF_3 to provide ionic contact between the reference and the working compartments were initiated. Spectral evidence for the superoxide ion in $LiF-NaF-KF$ (46.5–11.5–42.0 mole %) melts to which oxidizing agents MnF_3 or CoF_3 were added, points out the need for further purification of fluoride melts. Electroreduction of Bi(III), Hg(II), Hg(I), and Ni(II) in molten $NaCl-AlCl_3$ (37–63 mole % and other compositions) was investigated. Evidence for the electrochemical formation of Bi(I) was obtained. Chemical and electrochemical evidence for a new ion, Hg_3^{2+}, in chloroaluminates is reported. No evidence for Ni(I) or other subvalent nickel species in these melts was obtained. Raman spectra of $AlCl_3-NaCl$ melts for compositions ranging from 50–50 mole % to pure $AlCl_3$ were obtained. (auth)

9273 (TRG-Report-1567) NUMERICAL EVALUATION OF EQUILIBRIA INVOLVING $CO-CO_2-H_2-H_2O-CH_4$ MIXTURES AND NON-STOICHIOMETRIC OXIDES AND CARBIDES: A USER'S GUIDE TO CARBOX. Timperley, S. (United Kingdom Atomic Energy Authority, Sellafield (England). Reactor Group). 1969. 83p. Dep. CFSTI (U. S. Sales Only). UK 12s.

CARBOX was written in FORTRAN IV. Operating instructions and input formats for the program are given, together with details of numerical methods used, and flow diagrams. A table is given on standard free energy equations used in examples of input and output formats for the reactions U + O_2, U + C, and $\frac{2}{3}$ U + C. Data on gas composition in equilibrium with UO_2, UC, U_2C_3, and C are illustrated graphically. (P.C.H.)

9274 (UCRL-71890) ALFRED UNIVERSITY TALK [ON ANALYTICAL CHEMISTRY], OCTOBER 1968. Frazer, Jack W. (California Univ., Livermore. Lawrence Radiation Lab.). 30 Jul 1969. 40p. (CONF-681073-1). Dep. CFSTI.

From Symposium on Analytical Methods, Alfred, N. Y.

A discussion of analytical chemistry as a scientific discipline is presented. Examples are given of non-optimum and optimum interactions between analytical chemistry and other scientific disciplines. (D.H.M.)

9275 SUBMILLIMETER-WAVE SPECTRA OF AMMONIA AND PHOSPHINE. Helminger, Paul; Gordy, Walter (Duke Univ., Durham, N. C.). Phys. Rev.; 188: 100–8(5 Dec 1969).

Rotational transitions of different isotopic species of ammonia and phosphine have been observed in the $\frac{1}{3}$- to 1-mm region. The frequency of the $J = 0 \rightarrow 1$ transition of $^{14}NH_3$ is 572496.69 ± 0.60 Mc/sec and that for $^{15}NH_3$ is 572053.18 ± 0.50 Mc/sec. Special constants B_0 observed for the different isotopic species (in Mc/sec) are: 298114.68 for $^{14}NH_3$, 297359.32 for $^{15}NH_3$, 154173.25 for $^{14}ND_3$, and 153600.82 for $^{15}ND_3$. Structural dimensions for the ground vibrational state of ammonia obtained by isotopic substitution are 1.0136 Å for the bond length and 107°3′ for the bond angle. For PH_3, the rotational constants obtained (in Mc/sec) are: B_0 = 133,480.15, D_J = 3.95, and D_{JK} = −5.18; for PD_3 they are B_0 = 69,471.09, D_J = 1.02, and D_{JK} = −1.31. An upper limit of $\frac{1}{2}$ Mc has been put on the unknown inversion frequency of PH_3. (auth)

9276 EFFECT OF DEUTERATION ON THE MAGNETIC CRITICAL TEMPERATURES OF HYDROGEN-BONDED MATERIALS. Turrell, B. G.; Yue, C. L. (Univ. of British Columbia, Vancouver). Can. J. Phys.; 47: 2575–81(1 Dec 1969).

The change in the magnetic critical temperature caused by deuteration of the sample was measured for two hydrated salts. For antiferromagnetic $MnCl_2 \cdot 4H_2O$, a shift in the Néel point of −2.3% was observed when 96% of the protons were replaced by deuterons. For ferromagnetic $Cu(NH_4)_2Br_4 \cdot 2H_2O$, the Curie point was shifted by +0.8% on deuteration. These results are compared with measurements on other materials and the results semiquantitatively explained by proposing an intimate relation between the superexchange interaction and the hydrogen bond strength. (auth)(Canada)

9277 MOLTEN-SALT REACTOR CHEMISTRY. Grimes, W. R. (Oak Ridge National Lab., Tenn.). Nucl. Appl. Technol.; 8: 137-55(Feb 1970).

The large program of chemical research and development that led to selection of fuel and coolant compositions for the Molten Salt Reactor Experiment (MSRE) and for subsequent reactors of this type is summarized. Chemical behavior of the $LiF-BeF_2-ZrF_4-UF_4$ fuel mixture and behavior of fission products during power operation of MSRE are presented. A discussion of the chemical reactions that show promise for recovery of bred ^{233}Pa and for removal of fission product poisons from a molten salt breeder reactor is included. (auth)

9278 ELECTRONIC SPECTRA OF $^{130}Te_2$ AND $^{128}Te_2$. Jha, B. L.; Subbaram, K. V.; Rao, D. Ramachandra (Indian Inst. of Tech., Kanpur). J. Mol. Spectrosc.; 32: 383–97(Dec 1969).

The emission spectra of isotopically enriched $^{130}Te_2$ and $^{128}Te_2$ have been studied in the region 3850 to 4600 Å. Accurate band head data along with the vibrational analysis are reported consistent with the expected isotopic shifts. Rotational analyses of seven bands of $v'' = 0$ progression in both molecules suggest that the transition is of the type $0_u^+ - 0_g^+$ in Hund's case (c) coupling approximation. The molecular constants were obtained. (auth)

9279 HOMOGENEOUS HYDROGENATION OF DIOLEFINS CATALYZED BY TRICARBONYL CHROMIUM COMPLEXES. II. DEUTERATION. Frankel, E. N.; Selke, E.; Glass, C. A. (Northern Regional Research Lab., Peoria, Ill.). J. Org. Chem.; 34: 3936–42(Dec 1969).

Deuterium tracer studies provide direct evidence that 1,4 addition is the dominant mechanism of reduction catalyzed by arene–$Cr(CO)_3$. Catalytic deuteration of dienes yields almost exclusively monoenes-d_2 with deuterium located on the α-methylenes. Hydrogen and deuterium addition are predominantly molecular. Although no deuterium is exchanged with hydrogen in conjugated dienes, this exchange occurs at the α-methylenes in methyl linoleate and oleate and is apparently stereoselectively cis. With monoenes, positional and geometric isomerization by a 1,3-hydrogen shift is indicated. Key intermediates postulated include $D_2Cr(CO)_3$ and diene–$D_2Cr(CO)_3$ for 1,4 addition, cis monoolefin–$Cr(CO)_3$ for deuterium exchange, and π-allyl–$CrH(CO)_3$ for isomerization reactions. (auth)

9280 APPARATUS FOR THE CONTINUOUS PURIFICATION OF SUBLIMABLE SUBSTANCES. Balaskovic, Jacqueline; Gerard, Michel; Itier, Joseph (to Commissariat a l'Energie Atomique). British Patent 1,172,165. 26 Nov 1969. Priority date 9 Feb 1966, France.

An apparatus is described for the continuous purification by direct crystallization from the gaseous state of the vapor of a sublimable substance containing gaseous impurities, which have a triple point in relation to that of the vapor such that under the operating conditions of temperature and pressure of the apparatus the impurities remain gaseous. The apparatus is particularly suitable for the purification of UF_6. A crystallization chamber, which can be evacuated, is located above and leads to an airlock chamber, which is located above and leads to a sublimation chamber. The surface of the crystallization chamber can be cooled, and a heated scraper is provided inside the chamber for scraping the crystals from the cooled surface. The airlock is made up of a pair of baffles for sealing the airlock from the crystallization and sublimation chambers, and these baffles can move up and down with the motion of the scraper to seal each respective opening. Crystals drop into the airlock only when the lower baffle seals the opening between the airlock and the sublimation chamber and drop into the sublimation chamber only when the baffle seals the airlock chamber from the crystallization chamber. Thus the crystals are removed and the impurities remain in the vapor state. (B.L.M.)

9281 ACID- AND WATER-CATALYZED HYDROLYSIS OF p-NITROPHENYL ESTERS. Fife, Thomas H.; McMahon, Diane M. (Univ. of California, Los Angeles). J. Amer. Chem. Soc.; 91: 7481–5(17 Dec 1969).

The acid-catalyzed hydrolysis of a series of p-nitrophenyl esters of aliphatic carboxylic acids was studied in moderately concentrated HCl solutions at 30°C with acid concentration being varied from 1.36 to 6.24 M. Reasonably linear plots of log k_{obsd} vs log HCl concentration were obtained while degrees of curvature and small slopes were seen in plots of log k_{obsd} vs $-H_0$. Plots of log $k_{obsd} + H_0$ vs the logarithms of the activity of water in these solutions were linear in each case. The values of w were highly positive ranging from +4.40 with the butyrate ester to +5.15 for the trimethyl acetate ester. When ionic strength was held constant at 4.80 M with LiCl linear, plots of k_{obsd} vs HCl concentration were obtained. A plot of the logarithms of the second-order rate constants for hydrolysis at constant ionic strength vs E_s, the Taft steric effects constants, was linear with a slope, δ, of 0.59. Thus, there is less sensitivity to steric hindrance in the acyl group with these p-nitrophenyl esters than in the case of ethyl esters. A facile water catalysis was observed in the hydrolysis of the p-nitrophenyl and p-methoxyphenyl esters of dichloroacetic acid. Increasing the acid concentration produces a pronounced decrease in rate with the nitro-substituted ester but only a slight decrease with the methoxy-substituted compound. Thus, the magnitude of ρ for water catalysis

is highly dependent on the ionic strength of the medium. The hydrolysis of bis(4-nitrophenyl) carbonate was also studied at 50°C. There is a pH-independent reaction at pH values greater than 1. This reaction involves water catalysis and has a D_2O solvent isotope effect (k_{H_2O}/k_{D_2O}) of 2.88. As with p-nitrophenyl dichloroacetate there is no apparent acid catalysis, the rate of the reaction decreasing greatly as acid concentration is increased from 1.0 to 5.29 M. (auth)

9282 CATALYSIS OF α-HYDROGEN EXCHANGE. IX. ISOBUTYRALDEHYDE-2-d EXCHANGE IN THE PRESENCE OF AMINO ACIDS. Hine, Jack; Menon, B. C.; Mulders, Julien; Flachskam, Robert L. Jr. (Ohio State Univ., Columbus. Georgia Inst. of Tech., Atlanta). J. Org. Chem.; 34: 4083-7(Dec. 1969).

Catalysis of the deuterium exchange of isobutyraldehyde-2-d by glycine, β-alanine, γ-aminobutyric acid, δ-aminovaleric acid, and ε-aminocaproic acid was studied in the presence of pyridine and acetate buffers. In all cases there appears to be catalysis due to the reversible formation of an iminium ion from the aldehyde and amino acid followed by the removal of deuterium from the iminium ion by the various bases present. In no case could bimolecular catalysis via the internal attack of the carboxylate anion group be established. (auth)

9283 ELECTROPHORETIC STUDY OF URANIUM(VI), TIN(II), AND BISMUTH(III) COMPLEXATION. Carpentier, J.-M. (Faculte des Sciences de Rouen, Mont-Saint-Aignan, France). Bull. Soc. Chim. Fr.; No. 11, 3851-5(Nov 1969). (In French).

Decahydrated sodium sulfate electrophoresis demonstrates the condensation of UO_2^{2+} at pH 2.50. Electrophoresis in aqueous hydrochloric acid solution permits the progressive complexation of tin(II) and bismuth(III) to be followed. The instability constants of the different complexes can be determined. (auth)

9284 PAPER ELECTROPHORESIS AND CHROMATOGRAPHY OF URANIUM(VI) IN CHLORIDE-ORGANIC SOLVENT MEDIA. Ruis, A.; Grass, F. (Univ., Vienna. Oesterrichische Hochschule, Vienna). J. Chromatogr.; 45: 291-7(9 Dec 1969).

The electromigration of uranium(VI) using paper as carrier and its chromatographic behavior in hydrochloric acid (0.5 to 5 M) and metal chloride solutions containing varying amounts of ethanol or acetone is reported. The influence of the concentration of the ligands, as well as that of the organic solvents on the complex formation, and the significance of the solvation state of the uranyl species as well as the influence of the potential gradient applied, are discussed. (auth)

9285 SOLVENT DEUTERIUM ISOTOPE EFFECTS ON ACID-BASE REACTIONS. PART III. RELATIVE ACIDITY CONSTANTS OF INORGANIC OXYACIDS IN LIGHT AND HEAVY WATER. KINETIC APPLICATIONS. Salomaa, Pentti; Hakala, Rauni; Vesala, Seija; Aalto, Tarja (Univ. of Turku, Finland). Acta Chem. Scand.; 23: 2116-26(1969).

The relative acidity constants in light and heavy water have been measured for a large number of inorganic oxyacids at 25°C. It was found that the values of $\Delta pK = pK(D_2O) - pK(H_2O)$ vary very irregularly showing no simple relation to the acid strengths, in contrast to some earlier observations made on other acids. It is proposed that the anomalous behavior is primarily due to two factors: first, the values of ΔpK are not directly comparable for mono- and polybasic acids since they are composed of different numbers of isotope exchange equilibrium constants and, second, the values of ΔpK include free energies of transfer from light to heavy water which exhibit individual variations. An assumption is made that a linear free energy correlation exists between the equilibrium of proton transfer from the OH-bond and the isotope exchange equilibrium involving the same bond. It was found that this assumption merely requires that, for "idealized" pK values, i.e., for pK values from which the influence of change in the solvent from H_2O to D_2O has been eliminated, the pK values in light water are in linear relation to those in heavy water. This assumption leads to an empirical equation which describes the dependence of the isotopic fractionation factor on the acid strength of the OH-proton. The equation finds some support, apart from the theoretical arguments, from the following sources of experimental evidence. First, in cases in which directly measured fractionation factors are available these are in agreement with those calculated from the equation. Second, when application is made to the kinetics of hydronium ion-catalyzed reactions in which the acidity constant for the transition state can be evaluated, the equation permits a calculation of the relative reaction rates in light and heavy water. The values derived in this way agree excellently with those measured experimentally for reactions the mechanisms of which are firmly established. Further applications to acid-catalyzed reactions of unknown mechanisms are discussed. (auth) (Denmark)

9286 ISOTOPIC THERMAL DIFFUSION FACTOR FOR CO_2. Mathur, B. P.; Watson, W. W. (Yale Univ., New Haven). Contract AT(30-1)-2726. J. Chem. Phys.; 51: 5623-5(1 Dec 1969). (YALE-2726-545).

In continuation of a study of thermal diffusion in common, nonpolar, polyatomic gases, values of the isotopic thermal diffusion factor α_0 as a function of temperature for carbon dioxide are reported. A 60% $^{13}C^{16}O_2$–40% $^{12}C^{16}O_2$ mixture in a 10-tube metal trennschaukel was used over an average temperature range of 220 to 500°K. The experimental α_0 values can be represented in this temperature range by the equation, obtained by least squares: $\alpha_0 = -0.422 + 0.00155T$. In this linear variation, α_0 is -0.075 ± 0.070 at 239.5°K, and 0.343 ± 0.039 at 502.4°K, the highest average temperature of our measurements. The negative values of α_0 below about 250°K confirm earlier observations made in the case of isotopic N_2 and O_2 gases. As expected, the agreement between Chapman–Enskog theory and these experiments is poor. Also it was not possible to correlate the present results with the other transport properties of this gas. Besides the inadequacy of the usual potential models, the plausible reasons for this disagreement are: (a) neglect of the inelastic collisions and internal degrees of freedom in the theory, and (b) incipient dimerization at the lowest temperature. (auth)

9287 DISSOCIATION ENERGY OF Li_2 FROM LASER-EXCITED FLUORESCENCE. Velasco, R.; Ottinger, Ch.; Zare, R. N. (Univ. of Colorado, Boulder). Contract DA-31-124-ARO-D-139. J. Chem. Phys.; 51: 5522-32(1 Dec 1969).

The fluorescence spectra $B\ ^1\Pi_u - X\ ^1\Sigma_g^+$ of the molecular species $^6Li_2$, $^6Li^7Li$, and $^7Li_2$, excited by the cw lines of the argon ion laser, were observed and analyzed. Based on a short Birge–Sponer extrapolation of the vibrational levels of the ground state, the dissociation energy for the Li_2 molecule was determined to be $D_0^0 = 1.026 \pm 0.006$ eV. This value, combined with the dissociation limit of the upper state determined by Loomis and Nusbaum, proves that there is a hump of about 0.12 ± 0.04 eV above the asymptote of the potential curve of the Li_2 $B\ ^1\Pi_u$ state. Improved rotational and vibrational constants of the ground state of Li_2 were also obtained. A new technique is described which utilizes collision-induced rotational transfer to facilitate the v', J' assignment of the excited levels. (auth)

9288 TIME-DEPENDENT EFFECTS ASSOCIATED WITH THE 50°K RESISTIVITY ANOMALY IN THE Pd–H AND Pd–D SYSTEMS. Ho, N. S.; Manchester, F. D. (Univ. of Toronto). J. Chem. Phys.; 51: 5437-9(1 Dec 1969).

The characteristics of the time dependence of the electrical resistivity of Pd–H and Pd–D alloys in the vicinity of the 50°K resistivity anomaly are presented. It is suggested that there is a connection between the time dependence of the resistivity and the exothermic processes observed by others in these alloys at low temperatures, in that both effects are associated with the low-temperature annealing out of lattice damage produced by the transition at 50°K. (auth)

9289 MILLIMETER-WAVE SPECTRUM OF HYDROGEN PEROXIDE. Oelfke, William C.; Gordy, Walter (Duke Univ., Durham, N. C.). J. Chem. Phys.; 51: 5336-43(1 Dec 1969).

Some 50 rotational transitions of HOOH in the ground vibrational state were measured in the millimeter-wave region from 60 to 300 kMc/sec. Analysis of these transitions provides a complete set of values of the rotational constants and the accurate value of 342,885.0 ± 2.0 Mc/sec for the doublet splitting of the ground-state vibrational levels by internal barrier tunneling. The rotational constants in the Hamiltonian for the semirigid-rotor model with an internal axis of rotation are (in megacycles per second): $\nu_{11}^{+1} = 276{,}208.0 \pm 2.0$, $\nu_{11}^{-1} = 275{,}912.7 \pm 2.0$, $\beta_{11}^{+1} = 25{,}662.1 \pm 2.0$, $\beta_{11}^{-1} = 25{,}673.7 \pm 2.0$, $\gamma_{11}^{+1} = 542.96 \pm 0.5$, $\gamma_{11}^{-1} = 476.64 \pm 0.5$. The dihedral angle of the OH bonds is found to be 120°1' ± 15' for the lower level and 116°7' ± 15' for the upper level of the ground-state doublet. Some 30 millimeter-wave rotational transitions for DOOD were also measured, but analysis of them is not yet complete. (auth)

9290 POLARIZED SINGLET-TRIPLET ABSORPTION SPECTRA OF NORMAL AND DEUTERATED ANTHRACENE CRYSTALS. Durocher, G.; Williams, Digby F. (National Research Council of Canada, Ottawa). J. Chem. Phys.; 51: 5405-14(1 Dec 1969).

The singlet-triplet absorption spectra of anthracene-h_{10} and anthracene-d_{10} crystals were measured along the a and b crystal axes for temperatures between 350 and 4°K. The delayed fluorescence intensity was used to monitor the absorption. The Franck–Condon overlap factor was found to change with temperature, and the change is discussed in terms of variations in the C–C bond order. A vibrational analysis of the low temperature spectra is given. (auth)

9291 PHOSPHORESCENCE SPECTRUM, VIBRONIC ANALYSIS, AND LATTICE FREQUENCIES OF THE NAPHTHALENE MOLECULE IN A DEUTERONAPHTHALENE CRYSTAL. Hanson, David M. (California Inst. of Tech., Pasadena). J. Chem. Phys.; 51: 5063-9(1 Dec 1969).

The phosphorescence spectrum of naphthalene showing 94 transitions between 21,224 and 16,880 cm^{-1} was obtained. These data help resolve uncertainties in the vibrational assignments, suggest the presence of localized lattice vibrations in isotopic mixed crystals, and may indicate the relative importance of singlet–triplet coupling mechanisms in naphthalene and some halogenated naphthalene derivatives. The data were used to identify the corresponding absorption and phosphorescence of the pure crystal and might be used in explaining temperature, environmental, and isotope effects on the radiative or radiationless transition probabilities of the naphthalene molecule. (auth)

9292 ISOTOPIC VOLUME SHIFTS IN THE INERT GAS SOLIDS AT 0°K. Brown, J. S. (Univ. of Vermont, Burlington). J. Chem. Phys.; 51: 5243-5(1 Dec 1969).

Recent perturbative calculations of isotopic shifts in Ne are extended to include these shifts for the other inert gas solids. (auth)

9293 ENTHALPIES OF FORMATION OF TRIURANIUM OCTAOXIDE AND URANIUM DIOXIDE. Huber, Elmer J. Jr.; Holley, Charles E. Jr. (Los Alamos Scientific Lab., N. Mex.). J. Chem. Thermodyn.; 1: 267-72(1969). (LA-DC-10029).

The enthalpies of formation of U_3O_8 and UO_2 were determined by oxygen bomb calorimetry and found to be $\Delta H_f^\circ(U_3O_8, 298.15°K) = -(854.4 \pm 0.6)$ kcal mol^{-1} and $\Delta H_f^\circ(UO_2, 298.15°K) = -(259.3 \pm 0.2)$ kcal mol^{-1}. (auth)

9294 INORGANIC ION EXCHANGE MEMBRANES FOR USE IN ELECTRICAL SEPARATORY PROCESSES. Rajan, Krishnaswamy S.; Casolo, Angelo J. (to Secretary of the Interior). U. S. Patent 3,479,266. 18 Nov 1969. Filed 30 Nov 1967.

Inorganic ion exchange membranes, suitable for use in electrical separatory processes such as transport depletion and electrodialysis, are prepared from a hydrous oxide of an element from the group of alkaline earth metals, the actinide series, the lanthanide series, aluminum, zirconium, chromium, and tin. (Offic. Gaz.)

9295 INFRARED SPECTRA OF CRYSTALLINE CYCLOPENTANE AND CYCLOPENTANE-d_{10}. Schettino, V.; Marzocchi, M. P.; Califano, S. (Univ., Florence). J. Chem. Phys.; 51: 5264-76(15 Dec 1969).

Infrared spectra of crystalline cyclopentane and cyclopentane-d_{10} have been measured at different temperatures between 4000 and 200 cm^{-1}. Spectroscopic evidence showed that form I (–120°C) and form II (–140°C) have the same degree of disorder as the liquid. In the ordered crystal form III (–180°C) the molecule has a rigid bent conformation. By the mixed-crystal technique the nature of the observed splittings has been established. Thus, it was possible to show that the site symmetry of the molecule in form III is C_1, and packing concepts together with the spectroscopic data led to the choice of C_{2h}^5 as the possible space group of the lowest-temperature form. (auth)

9296 DIRECT OBSERVATION OF ISOTOPIC EXCHANGE IN THE SOLID STATE. Nath, A.; Klein, M. P. (Univ. of California, Berkeley). Nature (London); 224: 794-5(22 Nov 1969).

Previous studies on this topic are reviewed, and it is stated that there is considerable skepticism concerning the occurrence of isotopic exchange in solids, often expressed by use of the general and rather vague term "transfer annealing." Analytical techniques from which isotopic exchange has been inferred have involved dissolution of the solid material, and the observed "exchange" could have been related to the dissolution procedure. In order to avoid dissolution Moessbauer spectroscopy was applied to the study of a chilled sample of microcrystalline tris-dipyridyl Co(III) perchlorate trihydrate doped with a few drops of aqueous carrier-free $^{57}CoCl_2$. A moving sodium ferrocyanide absorber was used. An aliquot from this sample was also analyzed by ion exchange chromatography, and less than 1% of the activity was found in the coordinated form. The doped sample was then stored at 25°C for 4 days and a further Moessbauer run was made. Analysis of an aliquot of the stored sample indicated that 99% of the ^{57}Co activity was in the coordinated form. It was inferred that isotopic exchange occurred in the solid state. The method of study can be applied to isotopic exchange in any system containing a Moessbauer nuclide. Solid state isotopic exchange may also provide a simple method for the preparation of labeled compounds. (UK)

9297 INFRARED AND RAMAN SPECTRA OF SUBSTITUTED HYDRAZINES. II. UNSYMMETRICAL DIMETHYL HYDRAZINE. Durig, J. R.; Harris, W. C. (Univ. of South Carolina, Columbia). J. Chem. Phys.; 51: 4457-68(15 Nov 1969).

The infrared spectra of unsymmetrical dimethyl hydrazine, $H_2NN(CH_3)_2$, and unsymmetrical dimethyl hydrazine-d_2, $D_2NN(CH_3)_2$, were recorded in both the liquid and gaseous states from 33 to 4000 cm^{-1}. In addition the infrared spectrum of solid $H_2NN(CH_3)_2$ was measured from 33 to 4000 cm^{-1} and that of $D_2NN(CH_3)_2$ from 33 to 400 cm^{-1}. The Raman spectra of the liquid dimethyl hydrazines were obtained from 200 to 4000 cm^{-1} and depolarization measurements were made. The spectra were interpreted on the basis of C_1 symmetry, and all 30 vibrations were assigned on the basis of the band positions, relative intensities, and isotopic shift. The methyl torsional fundamentals were observed, and the barrier hindering the rotation of the CH_3 group was calculated to be 4.69 kcal/mole. A symmetrical threefold cosine-based potential function was employed in calculating a barrier height of 3.2 kcal/mole for the amino torsional vibration. Thermodynamic functions have been calculated for the temperature range 200 to 3000°K on the basis of a rigid-rotator harmonic-oscillator model for all vibrations except those involving the internal rotation of the amino and methyl groups, for which appropriate corrections were made. (auth)

9298 MICROWAVE SPECTRUM OF GERMACYCLOPENTANE. Thomas, E. C.; Laurie, Victor W. (Princeton Univ., N. J.). J. Chem. Phys.; 51: 4327-30(15 Nov 1969).

The microwave spectrum of four Ge isotopic species of the five-membered heterocyclic germacyclopentane ($C_4H_{10}Ge$) was investigated in the region 8 to 22 GHz. Rotational constants for the ground state of the ^{74}Ge species are: A = 5323.7, B = 2842.20, C = 2041.52 MHz. From excited states assigned to the lowest ring-deformation mode, a lower limit of about 500 cm^{-1} has been estimated for the barrier to pseudorotation. The molecule is found to be permanently twisted into a C_2 conformation with a twist angle of 18°, ∠CGeC = 98°, ∠GeCC = 106°, and ∠CCC = 115°. Stark-effect measurements give a dipole moment of 0.665 ± 0.007 D. For the ^{73}Ge species, the nuclear quadrupole coupling constants are found to be $\chi_{aa} = 15.89$ MHz, $\chi_{bb} = -10.29$ MHz, $\chi_{cc} = -5.60$ MHz. (auth)

9299 STATISTICAL PHASE-SPACE THEORY OF THE REACTION $C^+ + D_2$ INCLUDING THRESHOLD BEHAVIOR. Truhlar, Donald G. (California Inst. of Tech., Pasadena). J. Chem. Phys.; 51: 4617-23(15 Nov 1969).

The quantum-mechanical statistical phase-space theory of Pechukas, Light, and Nikitin is used to calculate the cross sections for the endothermic reaction $C^+ + D_2 \rightarrow CD^+ + D$ in the energy range 0 to 4 eV. The calculated cross section is about two times larger than the experimental results of Maier (1967) and has almost the same energy dependence below 2 eV. The statistical-theory threshold law is predicted to be valid only for a region less than 0.1 eV from threshold. Two different types of dependence of the reaction probability on incident impact parameter are emphasized, and one is used to explain the magnitude of the predicted cross section in this case. The intramolecular isotope effect in $C^+ + HD$ collisions is studied and the CH^+/CD^+ product ratio is predicted to be 0.92 at 1 eV. (auth)

9300 SOLVENT DEUTERIUM ISOTOPE EFFECTS ON ACID-BASE REACTIONS. PART I. THERMODYNAMIC THEORY AND ITS SIMPLIFICATIONS. Salomaa, Pentti (Univ. of Turku, Finland). Acta Chem. Scand.; 23: 2095-2106(1969).

Exact thermodynamic equations that describe the dependence of acid-base equilibrium constants and rate coefficients of acid- or base-catalyzed reactions in the H_2O-D_2O solvent system were derived. The assumptions which reduce these general equations to those introduced in an earlier extension of the so-called equilibrium theory of solvent deuterium isotope effects were critically examined as to their validity. These assumptions concern: the operational form of the hydrated hydrogen ion in its isotopic exchange reactions; the applicability of the postulate of the geometric mean (PGM) to the isotopic disproportionation equilibria involved; the independence of the isotope exchange equilibria of solvent composition in the H_2O-D_2O system; and the independence of the protolytic equilibria of the medium in the isotopically different waters. It was concluded that there actually is at present some experimental justification for most of the above-mentioned assumptions; the serious exception is the last-mentioned one and, perhaps also, to a minor degree, that concerning the application of PGM to various polybasic acid species involved, including the different lyonium ions present. Some experimental methods for further testing the validity or invalidity of these assumptions are outlined. (auth) (Denmark)

9301 PURE ROTATIONAL SPECTRUM AND ELECTRIC DIPOLE MOMENT OF CH_3D. Ozier, Irving; Ho, W.; Birnbaum,

George (North American Rockwell Corp., Thousand Oaks, Calif.). J. Chem. Phys.; 51: 4873-80(1 Dec 1969).

The pure rotational spectrum of the ground vibrational and electronic state has been observed using a far-infrared grating spectrometer. This spectrum is of particular interest because the electric dipole moment μ arises entirely from an isotopic substitution. Ten distinct lines have been observed in the frequency range from 40 to 120 cm^{-1}, and have been identified with the $(J \rightarrow J + 1)$ transitions for the rotational levels $J = 5-14$. For the $(6 \rightarrow 7)$ line, the absolute intensity and the linewidth were determined by a curve of growth method. It was found that, for this line, the dipole moment $\mu = (5.68 \pm 0.30) \times 10^{-3}$D and the broadening parameter $\gamma_0 = (0.075 \pm 0.012)$ cm^{-1}/amagat. This measurement constitutes the first correct experimental determination of the dipole moment of CH_3D. By making further intensity measurements on other lines, it was found that, to within 6%, μ is independent of J in the range $5 \leq J \leq 12$. A detailed account of the experimental methods used to make the intensity measurements is given. It was also determined that the rotational constant $B_0 = (3.882 \pm 0.002)$ cm^{-1} and the distortion constant $D_J = (7.7 \pm 0.3) \times 10^{-5}$ cm^{-1}. (auth)

9302 SOLVENT DEUTERIUM ISOTOPE EFFECTS ON ACID-BASE REACTIONS. PART II. VARIATION OF THE FIRST AND SECOND ACIDITY CONSTANTS OF CARBONIC AND SULFUROUS ACIDS IN MIXTURES OF LIGHT AND HEAVY WATER. Salomaa, Pentti; Vesala, Antti; Vesala, Seija (Univ. of Turku, Finland). Acta Chem. Scand.; 23: 2107-15(1969).

The first and second acidity constants of carbonic and sulfurous acids have been measured in light and heavy water and in their mixtures. The variation of the activity coefficients of CO_2(aq) and SO_2(aq) within this solvent system has also been studied from the partial pressures of carbon dioxide and sulfur dioxide over their dilute aqueous solutions. The results are discussed in terms of the equilibrium theory of solvent deuterium isotope effects. It was found that, if the ionic activity coefficients are assumed to be independent of solvent in the H_2O-D_2O system as postulated by this theory, it should be possible to calculate the equilibrium constant L, for the reaction $2\ D_3O^+ + 3\ H_2O = 2\ H_3O^+ + 3\ H_2O$, from the values for the first and second dissociation of the two acids studied. However, the results thus obtained were incompatible with each other and with those measured by other methods. This proves that the activity coefficient quotients involved undergo significant changes when going from light to heavy water. The results suggest an independent method for the determination of L from the data for carbonic and sulfurous acids, or for other acids displaying similar dissociation schemes. The method makes use of the fact that the activity coefficient quotients associated with changes in the isotope composition of the solvent become unity when pure light water is approached. The values obtained in this way, $L = 9.6 \pm 0.3$ (carbonic acid), and $L = 9.6 \pm 0.5$ (sulfurous acid), are in excellent agreement with those derived from other experimental sources. (auth) (Denmark)

9303 ESR STUDIES OF FREE RADICALS IN SOLUTION. I. OXIDATION OF CYSTEINE AND RELATED THIOLS WITH CERIC ION. Wolf, Walter (Univ. of Southern California, Los Angeles); Kertesz, Jean C.; Landgraf, William C. J. Magn. Resonance; 1: 618-32(Nov 1969).

A system was developed for the study of sulfur free radicals in solution by oxidation of a variety of thiols with Ce^{4+} ion. This system generates at least four free radical species, labelled "A," "B," "C," and "D," with G-values at 2.0106 ± 0.0002, 2.0186 ± 0.0002, 2.0032 ± 0.0002, and 2.0151 ± 0.0002, respectively. Free radical "A" was identified as the RS· free radical and when the thiol oxidized is a primary mercaptan, such as cysteine, the signal is a 1:2:1 triplet with α_{C_1H} of 9.5 G and 3.5 gauss line width. With thiolacetic acid the expected 1:1 doublet was observed with α_{C_1H} of 8.5 G and 3.0 gauss line width, whereas the tertiary thiols gave the expected singlet with a 2.5 gauss line width. The experimental conditions for studying such systems are fully described, as well as the conditions under which "B," "C," and "D" are formed. The possible identity of such species, and the potential of this technique for the study of RS· free radicals and their role in radioprotection and/or radiation damage are discussed. (auth) (UK)

9304 REACTION OF IMPURITIES OF ALUMINUM OXIDE WITH TANTALUM. Elyutin, V. P.; Mozzhukhin, E. I.; Varenkov, A. N. Izv. Akad. Nauk SSSR, Metal.; No. 5, 47-50(Sep-Oct 1969). (In Russian).

Studies of the reaction of tantalum with aluminum oxide impurities showed that a solid solution can be formed in a method similar to that in the reaction of niobium with aluminum oxide impurities. The equilibrium conditions for this reaction can be evaluated thermodynamically. (M.C.G.)

9305 SECONDARY DEUTERIUM ISOTOPE EFFECTS FOR RADICAL-FORMING REACTIONS. Wolf, Richard Appleby. Eugene, Oreg.; Univ. of Oregon (1968). 217p.

Thesis.

The α and β secondary D isotope effects for the radical-forming decompositions of some t-butyl peresters, were studied in the hope of gaining some insight to the theory of these isotope effects. The first order decomposition rate constants of these compounds were determined by following the disappearance of the carbonyl stretch peak in the infrared region. The isotope effects for all the peresters were determined in isooctane, and those for two were also found in chlorobenzene. The effect of the very polar solvent 90% aqueous dioxane was also determined for one perester 5. A double labeling method was developed for directly measuring the D isotope effects without measuring the rate constants of the protonated and deuterated peresters. Mixtures of deuterated peresters labeled with excess ^{18}O in the carbonyl oxygen were decomposed. A theory to predict the β secondary D isotope effects from molecular orbital calculations was developed. The formula was derived from Streitwieser's simplification of the complete Bigeleisen formula for the calculation of isotope effects in terms of vibrational frequencies. Several other theories for α and β secondary D isotope effects are discussed in the light of results for the literature. Most of these alternative theories are not quantitative as is the theory developed in this work. (Diss. Abstr.)

9306 SYNTHESIS OF 2,3,6,7-DIBENZO(b,h)BIPHENYLENE AND STUDIES OF D^+ EXCHANGE IN SOME BIPHENYLENES. Talwar, Satya Sarup. Ithaca, N. Y.; Cornell Univ. (1969). 96p.

Thesis.

Approaches to the synthesis of compounds containing 2 fused 4n-conjugated cyclic polyolefins, e.g., 2 fused cyclobutadiene (butalene), or their derivatives are examined. A key intermediate in one of the projected syntheses was 2,3,6,7-dibenzo(b,h)biphenylene. Two new methods for its preparation are explored. A study of the rates of D^+ exchange of biphenylene, benzo(b)biphenylene and dibenzo(b,h)biphenylene in $CF_3COOH-D_2SO_4$–chlorobenzene was made. However no reliable rate constants could be obtained from the experimental data. Probable reasons for the lack of poor precision in these results are discussed. (Diss. Abstr.)

9307 ELECTROCHEMICAL PROPERTIES OF HEPTAVALENT NEPTUNIUM. Simakin, G. A.; Matyashchuk, I. V. Radiokhimiya; 11: 481-2(1969). (In Russian).

The electrochemical oxidation of Np(VI) to Np(VII) was studied in NaOH solutions on platinum electrodes. It was concluded that the oxidation-reduction reaction is realized with the participation of hydroxide ions and that Np(VII) is thermodynamically unstable in alkaline media. (M.C.G.)

9308 HEAT OF FORMATION OF UOF_2. Vdovenko, V. M.; Romanov, G. A.; Solntseva, L. V. Radiokhimiya; 11: 466-8 (1969). (In Russian).

The heat of dissolution of $UOF_2 \cdot 2H_2O$ in HCl was determined. The resistance of the crystal to dissociation was also studied. The heat of formation of UOF_2 was calculated from the data obtained. (M.C.G.)

9309 COMPLEX FORMATION OF ACTINIDES WITH ANIONS OF ACIDS IN AQUEOUS SOLUTIONS. Moskvin, A. I. Radiokhimiya; 11: 458-60(1969). (In Russian).

Investigations were carried out on the formation of complexes by actinides with a series of acids in aqueous solutions. Experimental data were subjected to mathematical treatment and compositions and stability constants considered. (M.C.G.)

9310 INVESTIGATIONS OF OXIDATION–REDUCTION REACTIONS OF ACTINIDE ELEMENTS. XIII. KINETICS OF THE REACTION NEPTUNIUM(IV)–PLUTONIUM(VI) IN PERCHLORATE SOLUTIONS. Rykov, A. G.; Timofeev, G. A.; Chistyakov, V. M. Radiokhimiya; 11: 455-8(1969). (In Russian).

Thermodynamic parameters were determined for the oxidation of neptunium(IV) by plutonium(VI) in perchlorate solutions. It was found that the reaction rate is inversely proportional to the hydrogen ion concentration. (M.C.G.)

9311 INVESTIGATIONS OF OXIDATION–REDUCTION REACTIONS OF ACTINIDE ELEMENTS. XII. KINETICS OF REACTIONS IN THE SYSTEMS URANIUM(VI)–IRON(III)–LEAD(0) AND NEPTUNIUM(V)–PLUTONIUM(IV)–LEAD(0). Rykov, A. G.; Timofeev, G. A.; Chistyakov, V. M. Radiokhimiya; 11: 450-5 (1969). (In Russian).

Studies were made of the kinetics of the reactions of lead with U(VI) and Fe(III) in perchlorate solutions, Np(V) and Pu(IV) in nitrate solutions, and Np(V) in perchlorate solutions. The reac-

tions were studied by differential potentiometry and spectrophotometry. (M.C.G.)

9312 ISOLATION OF ATOMIC OXYGEN IN THE THERMAL DECOMPOSITION OF CERTAIN URANIUM OXIDES. Malinin, G. V.; Yadrintsev, V. B.; Tolmachev, Yu. M. Radiokhimiya; 11: 438-42(1969). (In Russian).

Reactions in the thermal decomposition of certain uranium oxides in air were investigated. It was found that on thermal decomposition of $\beta-UO_3$, $\epsilon-UO_3$, $\alpha-UO_{3-x}$, $UO_4 \cdot 2H_2O$, and amorphous UO_3, only molecular oxygen is isolated. On thermal decomposition of U_3O_8 and UO_{2+x} both atomic and molecular oxygen are isolated. (M.C.G.)

9313 ABSORPTION SPECTRA OF URANIUM OXIDES. II. INFRARED SPECTRA OF OXIDES IN THE COMPOSITION REGION FROM $UO_{2.50}$ TO $UO_{2.64}$. Il'inskaya, T. A.; Kuzin, V. I.; Tolmachev, Yu. M. Radiokhimiya; 11: 433-8(1969). (In Russian).

Investigations were made of the absorption spectra of uranium oxides formed in the process of oxidation of U_3O_5 in air and on heating in vacuum. A change in frequency of bands in the spectra in proportion to the oxidation was observed. The displacement of bands was explained by elongation of bonds located in the plane perpendicular to the chain $-O-U-O-$. It was found that the upper boundary of thermal stability of U_3O_5 is below 170°C. (M.C.G.)

9314 ELECTROLYTIC REDUCTION OF URANYL IONS IN OXALATE SOLUTIONS. Peretrukhin, V. F.; Krot, N. N.; Gel'man, A. D. Radiokhimiya; 11: 428-33(1969). (In Russian).

It is shown that the electrolytic reduction of uranyl ions to U(IV) in solutions of ammonium oxalate at pH = 3 to 5 on steel, graphite, or tantalum cathodes occurs only through disproportionation of U(V). Stages that limit the rate of accumulation of U(IV) include the diffusion of uranyl ions to the cathode. Optimum regions of cathode potential were found. The effects of stirring, temperature, and impurities were determined. (M.C.G.)

9315 INVESTIGATIONS OF OXIDATION-REDUCTION REACTIONS OF ACTINIDE ELEMENTS. XI. THE KINETICS OF REDUCTION OF URANIUM(VI) AND NEPTUNIUM(VI) BY SOLID METALS. Rykov, A. G.; Timofeev, G. A.; Yakovlev, G. N.; Chistyakov, V. M. Radiokhimiya; 11: 425-28(1969). (In Russian).

The kinetics of reduction of uranium(VI) and neptunium(VI) by lead and silver, respectively, were studied. It is shown that the rate of these heterogeneous reactions is determined only by the rate of diffusion of reacting ions to the surface of the reducing agent. (M.C.G.)

9316 INVESTIGATIONS OF OXIDATION-REDUCTION REACTIONS OF ACTINIDE ELEMENTS. X. THE KINETICS OF REDUCTION OF METALLIC PLUTONIUM(IV) BY LEAD, COPPER, AND SILVER. Rykov, A. G.; Timofeev, G. A.; Yakovlev, G. N.; Chistyakov, V. M. Radiokhimiya; 11: 418-24(1969). (In Russian).

The kinetics of the heterogeneous reactions in the reduction of Pu(IV) and Fe(III) by Pb, Cu, and Ag were studied. Diffusion processes were found to be characteristic in all these reactions. The rate of the reaction depended on the geometrical conditions and not on the nature of the reducing agent. The activation energies of the reactions were determined. (M.C.G.)

9317 INVESTIGATIONS OF OXIDATION-REDUCTION REACTIONS OF ACTINIDE ELEMENTS. IX. THE KINETICS OF THE REACTION BETWEEN NEPTUNIUM(IV) AND PLUTONIUM (IV) IN PERCHLORATE MEDIA. Rykov, A. G.; Timofeev, G. A.; Yakovlev, G. N. Radiokhimiya; 11: 413-18(1969). (In Russian).

The kinetics of the oxidation of Np(IV) by Pu(IV) were studied in perchlorate solutions with an ionic strength of 2. It was established that the reaction passes through one activated complex, formed according to the equation: $Np(IV) + Pu(IV) + 2H_2O \rightleftharpoons (*)^{5+} + 3H^+$. The thermodynamic parameters of the reaction were studied and the entropy of the activated complex calculated. (M.C.G.)

9318 THE HEPTAVALENT STATE OF TRANSURANIUM ELEMENTS. V. THE REACTION OF NEPTUNIUM(VII) WITH REDUCING AGENTS IN ALKALINE SOLUTIONS. Shilov, V. P.; Krot, N. N. Radiokhimiya; 11: 399-407(1969). (In Russian).

Neptunium(VII) in solutions with OH^- = 0.1 to 0.5 g-ion/l is reduced by Na_2SO_3 (0.05 to 0.1M) at a normal rate at 20 to 35°C. A mechanism is proposed for the reduction process. The activation energy of the reaction was found to equal 22.5 ± 2 kcal/mole at an OH^- concentration of 0.5 g-ion/l. The rapid reduction of Np(VII) by 0.1 to 0.3 M KI without heating proceeds only at an OH^- concentration of 0.03 g-ion/l. These reduction reactions are catalyzed by Co^{3+}, Cu^{2+}, and Mn^{7+} at concentrations beginning at (1 to 3) × 10^{-7} M. Semiquantitative data were obtained on the stability of Np(VII) in alkaline solutions in the presence of various reducing agents. (M.C.G.)

9319 CHEMICAL EXPERIMENTS WITH ELEMENT 103: CHLORIDE ABSORPTION FROM FLOWING GAS. Chuburkov, Yu. T.; Belov, V. Z.; Tsaletka, R.; Shalaevskii, M. R.; Zvara, I. Radiokhimiya; 11: 394-9(1969). (In Russian).

Physical properties of the chlorides of elements 102 and 103 were compared with properties of other chlorides. It was concluded that elements 102 and 103 should be distributed in the periodic system as ekaytterbium and ekalutetium, respectively. (M.C.G.)

9320 DEPENDENCE OF THE POLAROGRAPHIC BEHAVIOUR OF EUROPIUM ON SOLVENT AND SUPPORTING ELECTROLYTE. Gutmann, V.; Peychal-Heiling, G. (Technische Hochschule, Vienna). Monatsh. Chem.; 100: 1423-33(Jul-Aug 1969). (In German).

Polarographic investigations on europium(III) perchlorate were carried out in acetonitrile, propanediol-1,2-carbonate, trimethyl phosphate, N,N-dimethylformamide, N,N-dimethylacetamide and dimethyl sulfoxide. $E_{\frac{1}{2}}$, the diffusion coefficients, the diffusion current constants and the reversibility or irreversibility of the electrochemical reactions are given. A linear relationship was found between $E_{\frac{1}{2}}$ for the wave Eu(III) – Eu(II) and the donor number of the solvent investigated even when the supporting electrolyte contained a complexing anion. The donor strength of the anions and that of the solvent molecules increases in the following order: I^- ~ AN < PDC < TMP < DMF < DMA < Cl^- ~ DMSO < N_3^-. (auth)

9321 PHYSICAL-CHEMICAL INVESTIGATION OF URANIUM HEXAFLUORIDE-CARBON TETRACHLORIDE BINARY SYSTEM. Sudarikov, B. N.; Prokopets, V. E.; Katal'nikov, S. G.; Kosarev, V. G.; Minaev, V. A. At. Energ. (USSR); 27: 504-6(Dec 1969). (In Russian).

UF_6-CCl_4 system was selected as an example for investigation of uranium hexafluoride solutions in organic solvents. Heterogenous liquid-solid equilibrium and the dependence of the pressure of saturated uranium hexafluoride solution vapor in the carbon tetrachloride on the concentration and temperature were investigated. Liquid-solid equilibrium was studied by differential thermal analysis with the use of a procedure that allowed thermocouple reading on the EPP-09 electronic potentiometer. Saturated vapor pressure was measured by a static method. On the basis of these measurements the UF_6-CCl_4 system phase diagram was constructed. Complex compounds in the system were absent. (auth)

9322 THE HEPTAVALENT STATE OF TRANSURANIUM ELEMENTS. VI. STUDY OF CERTAIN METHODS OF OXIDATION OF PLUTONIUM(VI). Komkov, Yu. A.; Peretrukhin, V. P.; Krot, N. N.; Gel'man, A. D. Radiokhimiya; 11: 407-12(1969). (In Russian).

The oxidation of plutonium(VI) in alkaline solutions by persulfate and hypobromite ions and by electrochemical methods was studied. The reaction was studied spectrophotometrically using $K_2S_2O_8$ at 80 to 90°C in KOH solutions of 0.2 to 1.5M. The reaction rate reached a maximum at 0.5M KOH, but the yield of Pu(VII) was maximum at approximately 1M KOH. Pu(VI) was also oxidized by KBrO in KOH and electrochemically. (M.C.G.)

9323 SECONDARY DEUTERIUM ISOTOPE EFFECTS ON THE SOLVOLYSIS OF EXO-8- AND ENDO-8-TETRACYCLO [4,3,0,$0^{2,4}$,$0^{3,7}$]NONYL ("DELTACYCLYL") BROSYLATES. Freeman, Peter K.; Blazevich, Joseph N. (Oregon State Univ., Corvallis). J. Chem. Soc., D; No. 23, 1357-8(1969).

Secondary β-deuterium isotope effects measured for acetolysis of exo-9-deuterio-exo-8-deltacyclyl brosylate support the direct generation of a delocalized intermediate from exo-brosylate and a localized ion from endo-brosylate. (auth) (UK)

9324 CALCULATED RADIATIONLESS TRANISITON RATES FOR BENZENE AND DEUTEROBENZENE. Burland, D. M.; Robinson, G. W. (California Inst. of Tech., Pasadena). J. Chem. Phys.; 51: 4548-59(15 Nov 1969).

Radiationless rates were calculated for the $^3B_{1u} \rightsquigarrow {}^1A_{1g}$ transitions of benzene and perdeuterobenzene as well as for the $^1B_{2u} \rightsquigarrow {}^1A_{1g}$ transition of benzene. The rates were calculated using a model that considers the radiationless transition as a tunneling process between two multidimensional potential surfaces and assuming both harmonic and anharmonic vibrational potentials. The importance of anharmonicity for the radiationless transition rate provides a possible explanation of environmental effects on these

rates. Whenever possible, experimental parameters were used in the calculation. To this end experimental values were obtained for the anharmonicities of the carbon–carbon and carbon–hydrogen vibrations and the size of the lowest triplet state of benzene. (auth)

9325 PHONON CURVES AND FREQUENCY SPECTRUM FOR HYDROGEN-BONDED SYSTEMS: SOLID HF AND DF. Tubino, Riccardo; Zerbi, Giuseppe (CNR, Milan. Politecnico, Milan). J. Chem. Phys.; 51: 4509-14(15 Nov 1969).

A few hydrogen-bonded systems can be considered as polymers; hence, dispersion curves ν(k) and frequency distribution g(ν) can be calculated. Molecular vibrations of a single chain of hydrogen-bonded HF and DF were studied throughout the first Brillouin zone. $k = 0$ fundamental modes are calculated. From ν(k) and g(ν) it is possible to propose a better interpretation of the previously reported inelastic neutron scattering spectrum. The limitations of the model used are discussed and suggestions for a more refined approach of the problem are given. (auth)

9326 DIFFUSION OF HYDROGEN IN BORON–PALLADIUM ALLOYS. Allard, K. D.; Flanagan, Ted B. (Univ. of Vermont, Burlington). J. Phys. Chem.; 74: 298-305(22 Jan 1970).

The diffusion of hydrogen in a series of boron–palladium alloys was investigated using an electrochemical relaxation technique. Results show that the values of the diffusion coefficients determined at $n_H \to 0$, where $n_H = H/Pd$, atomic ratio, decline steadily with boron content from that of pure palladium. This behavior is in marked contrast to that of substitutional alloys of palladium. The dependence of the diffusion coefficients upon boron content supports the view that in these alloys boron occupies interstitial sites. A quantitative theory is advanced which satisfactorily explains the results. (auth)

9327 KINETIC STUDY OF THE REACTIONS OF FLUORINE WITH THE TETRAFLUORIDE AND DIOXIDE OF NEPTUNIUM. Matcheret, G. (CEN, Fontenay-aux-Roses, France). Radiochem. Radioanal. Lett.; 2: 249-55(27 Dec 1969). (In French).

The reactions of elementary fluorine with neptunium compounds were studied using a thermogravimetric method. The mechanism and the kinetics of these reactions varies according to the nature of the compound. With neptunium tetrafluoride the reaction proceeds in a single step. The kinetics correspond to a uniform attack of the entire surface of the sample and obeys the kinetic law: $|1-\alpha|^{1/3} = 1 = k_{rel}\, t$. The reaction with neptunium dioxide involves two steps, neptunium tetrafluoride being the intermediate compound. The kinetics of the first step corresponds to a diffusion process and obeys the kinetic law: $\log|1-\alpha| = K\, t^{1/2}$. The kinetics of the second step correspond to a uniform attack of the entire surface of the sample. (auth)

9328 ELECTRONOGRAPHIC STUDIES OF URANIUM AND THORIUM TETRAHALIDES IN THE GASEOUS PHASE. II. STUDIES OF URANIUM AND THORIUM TETRACHLORIDES AND TETRABROMIDES. Ezhov, Yu. S.; Akishin, P. A.; Rambidi, M. G. (Moscow State Univ. Inst. of High-Temperature, Moscow). Zh. Strukt. Khim.; 10: 763-8(Sep-Oct 1969). (In Russian).

Electronographic studies were made of uranium and thorium tetrachlorides and tetrabromides in the gaseous phase. The basic structural parameters were determined for UCl_4, UBr_4, $ThCl_4$, and $ThBr_4$. A possible geometric configuration for these molecules was postulated. (tr-auth)

9329 MAGNESIOTHERMIC PRODUCTION OF MOLYBDENUM FROM MOLYBDIC ANHYDRIDE WITHOUT USE OF A FURNACE. Perminov, V. P.; Neronov, V. A. (Novosibirsk Inst. of Physical and Chemical Ore Treatment, USSR). Izv. Sib. Otd. Akad. Nauk SSSR; No. 12, Ser. Khim. Nauk, No. 5, 72-7(Sep 1969). (In Russian).

Molybdenum (99.2 to 99.4% purity) was obtained from molybdic anhydride by magnesiothermics without using a furnace. The effects of calcium oxide, magnesium, and potassium chlorate content in the charge as well as the influence of the density of the briquette and pressure of the gaseous fluid on the yield of molybdenum were investigated. Optimum conditions were found for the production of molybdenum with a maximum yield of 68%. (auth)

9330 INTERPRETATION OF THE ABSORPTION SPECTRUM OF CESIUM URANYL CHLORIDE CRYSTALS. Komyak, A. I.; Sevchenko, A. N. (Lenin Belorussian State Univ., Minsk). Dokl. Akad. Nauk SSSR; 188: 318-21(11 Sep 1969). (In Russian).

The absorption spectrum of cesium uranyl chloride was investigated at 77°K, establishing a correlation between the oscillation frequency of the lower and upper excitation levels. The crystals used for the study were grown from slightly acid saturated aqueous solutions of the salt by free evaporation at room temperature. The crystals were found to be monoclinic, optically biaxial, and negative. The pure electron transition at 77°K has a frequency of 20092 cm^{-1}, coinciding with the short-wave line of the luminescence spectrum. It was found possible to separate all absorption lines that belong to the first electron transition. A sharply polarized line at the 20635 cm^{-1} region was attributed to the 0–0 transition of the second excited level. Altogether 4 excitation electron oscillation lines could be identified in the absorption spectrum of $CsUO_2Cl_2$ at 77°K. (TTT)

9331 CATALYTIC BEHAVIOR OF ORGANIC SEMICONDUCTORS: HYDROGEN EXCHANGE ON BARIUM-NAPHTHACENE ION SALTS. Wakayama, Nobuyuki; Inokuchi, Hiroo (Tokyo Univ.). J. Catal.; 15: 417-19(Dec 1969).

The hydrogen exchange reaction on alkali metal– and alkali earth metal–naphthacene ion salts was observed by means of para–ortho hydrogen conversion. In the case of mononegative ion salt (naphthacene)$^-M^+$, the para-ortho hydrogen conversion proceeded by the physical mechanism. In the case of the naphthacene dinegative ion salts with alkali metal (naphthacene)$^{2-}2M^+$, the chemisorptive mechanism was predominant. Further, hydrogen exchange over the (naphthacene)$^{2-}Ba^{2+}$ salt occurred by way of exchange reaction between gaseous hydrogen and the hydrogen atom of the hydrocarbon. A proposal to explain the surface reaction is submitted. (auth)

9332 ISOTOPE EFFECTS IN THE ELECTROMIGRATION OF TIN(II) IONS IN MOLTEN $SnCl_2$. Golyshev, S. I.; Lyubimov, V. N.; Tikhomirov, I. A. (Tomsh Polytechnic Inst., USSR. Inst. of Inorganic Chemistry, Novosibirsk, USSR). Izv. Sib. Otd. Akad, Nauk SSSR; No. 12, Ser. Khim. Nauk, No. 5, 3-7(Sep 1969). (In Russian).

The value of mass effect determined as $\mu = (\Delta u/u)/(\Delta m/m)$, was found experimentally for tin isotopes in the electromigration of tin(II) ions in molten salt $SnCl_2$. In the temperature interval from 340 to 590°C this value can be represented by an empirical expression $\mu = -0.069[1-0.0003(T-340)]$. (auth)

9333 ISOTOPE EFFECTS IN THE REACTION $C_2D_5 + D_2 = C_2D + D$. Hikida, Takumi; Le Roy, D. J. (Univ. of Toronto). J. Amer. Chem. Soc.; 91: 7675-8(31 Dec 1969).

Complementing a recent study of the reaction of ethyl radicals with molecular hydrogen, a similar study was made of the reaction of ethyl-d_5 radicals with molecular deuterium in the range 240 to 320°C. The mercury $6(^3P_1)$ photosensitized decomposition of deuterium in the presence of ethylene-d_4 was used to generate ethyl-d_5 radicals. The rate constant (cm^3 $mole^{-1}$ sec^{-1}) is given by $\log k_D = 11.7_5 - (12.9/\theta)$. The ratio k_H/k_D was treated by a transition state theory model using bond-energy–bond-order methods. Theory and experiment are in reasonable good agreement when allowance is made for quantum mechanical tunneling. (auth)

9334 KINETIC ISOTOPE EFFECTS AND CD_3 VS. CH_3 MIGRATION. Schubert, W. M.; LeFevre, Paul H. (Univ. of Washington, Seattle). J. Amer. Chem. Soc.; 91: 7746-8(31 Dec 1969).

Studies were made to compare the kinetic isotope effects with the extent of CH_3 vs. CD_3 migration to provide a direct means of determining whether or not the step of methyl migration corresponds to the rate-controlling step. Results indicated that the methyl migration is the rate-controlling step. (M.C.G.)

9335 PROGRESS IN COORDINATION CHEMISTRY. Proceedings of the Eleventh International Conference on Coordination Chemistry, Haifa and Jerusalem, September 1968. Cais, Michael (ed.). New York; American Elsevier Publishing Company, Inc. (1968). 882p. $45.00. (In several languages). (CONF-680912-(Absts.)).

The conference proceedings are divided into the following sections: (1) Coordination Compounds in Heterogeneous Catalysis, 22 papers; (2) Photochemistry in Coordination Compounds, 12 papers; (3) Kinetics and Mechanics of Reactions of Coordination Compounds, 32 papers; (4) Synthesis, Structure, and Stereochemistry of Coordination Compounds, 63 papers; (5) Organometallic Chemistry, 43 papers; (6) Coordination Compounds in Biology, 17 papers; (7) Theories of Bonding in Coordination Compounds, 23 papers; (8) Physical Methods in Coordination Compounds, 40 papers; (9) Coordination Compounds in Solvent Extraction, 38 papers; and (10) Coordination Compounds in Nonaqueous Solvents, 23 papers. Separate abstracts were prepared for 27 papers. Three papers were previously abstracted for NSA. (B.L.M.)

For abstracts of individual papers see: 9336–9344, 9409, 9410, and 9468–9483.

9336 LOW-TEMPERATURE ABSORPTION SPECTRA OF ACTINIDE CYCLOPENTADIENIDES. Carnall, W. T.; Fields, P. R.; Pappalardo, R. G. (Argonne National Lab., Ill.). pp

411-13 of Progress in Coordination Chemistry. /Cais, Michael (ed.). New York; American Elsevier Publishing Company, Inc. (1968).

From 11th International Conference on Coordination Chemistry, Haifa and Jerusalem, Israel. See CONF-680912-(Abstr.).

In order to explore how far the $5f^n$ shell is unaffected by its environment, the cyclopentadienides of Np(IV), Pu(III), and Am(III) were prepared. The spectra suggested an unusually strong interaction of the cations with the cyclopentadienyl ligand. (M.C.G.)

9337 THERMODYNAMICS OF ACTINOID COMPLEX FORMATION. Ahrland, Sten (Univ. of Lund, Sweden). pp 539-41 of Progress in Coordination Chemistry. /Cais, Michael (ed.). New York; American Elsevier Publishing Company, Inc. (1968).

From 11th International Conference on Coordination Chemistry, Haifa and Jerusalem, Israel. See CONF-680912-(Abstr.).

Stability constants are given for various fluoride and chloride complexes formed by actinoid ions in aqueous solutions. For all these acceptors, the fluoride complexes were incomparably stronger. (M.C.G.)

9338 SPECTRAL STUDIES OF URANIUM(V) COMPLEXES. Selbin, J.; Ortego, J. D.; Gritzner, G. (Louisiana State Univ., Baton Rouge). pp 550-2 of Progress in Coordination Chemistry. /Cais, Michael (ed.). New York; American Elsevier Publishing Company, Inc. (1968).

From 11th International Conference on Coordination Chemistry, Haifa and Jerusalem, Israel. See CONF-680912-(Abstr.).

The unstable UO_2^+ species was produced for spectral investigation by controlled potential electrolysis of very dry dimethylsulfoxide (DMSO) solutions of $UO_2(DMSO)_5(NO_3)_2$ under an Ar atmosphere. Three band maxima were observed in the 6100 to 20,000 cm^{-1} region. The main peak occurred at 6620 cm^{-1}, and the other two maxima at roughly $^1/_{10}$ the intensity were observed at 12,940 and 15,080 cm^{-1}. The following solid compounds of U(V) were prepared: $MUCl_6$ (where M = Rb and $(n\text{-}C_3H_7)_4N$); $UCl_5 \cdot SOCl_2$; $UCl_5 \cdot PCl_5$; and $UCl_5 \cdot$ TCAC (TCAC = trichloroacryloyl chloride). Infrared spectra were obtained for nujol mulls of the solids. Electronic spectra were recorded for the $MUCl_6$ compounds dissolved in $SOCl_2$, for $UCl_5 \cdot$ TCAC dissolved in $SOCl_2$, C_6H_6, CS_2, or CCl_4; for CCl_4 and $SiCl_4$ solutions of UCl_5. An interpretation of the spectrum of UCl_5^- is presented. ESR spectra of powdered samples of $UCl_5 \cdot$ TCAC, $UCl_5 \cdot SOCl_2$, $UCl_5 \cdot PCl_5$, and both $MUCl_6$ compounds were measured. (B.L.M.)

9339 A SPECTROPHOTOMETRIC STUDY OF THE COMPLEXATION OF AMERICIUM WITH AMINOPOLYACETIC ACIDS. Delle Site, A.; Baybarz, R. D. (Oak Ridge National Lab., Tenn.). pp 619-20 of Progress in Coordination Chemistry. /Cais, Michael (ed.). New York; American Elsevier Publishing Company, Inc. (1968).

From 11th International Conference on Coordination Chemistry, Haifa and Jerusalem, Israel. See CONF-680912-(Abstr.).

The complexation of Am^{3+} with 8 polyaminopolyacetic acids varying in size from iminodiacetic (IDA) to tetraethylenepentaaminehepta-acetic was investigated by means of absorption spectrophotometry. The composition and pH range of stability of 24 complexes were determined. Instability constants were calculated for 13 of the complexes. The study indicated that small ligands, such as IDA can form complexes with Am^{3+} in which as many as 5 molecules of ligand are attached to the metal ion. The larger ligands are capable of forming complexes of the type 2:3 and 1:2 metal-to-ligand ratios. Hydroxy groupings on aminopolyacetic acid ligands appear to enter into covalent bonding with Am^{3+}. The results for all the complexes are tabulated. (B.L.M.)

9340 STUDY OF THE SYSTEMS: URANYL NITRATE-CALCON [3-HYDROXY-4-[(2-HYDROXY-1-NAPHTHYLAZO]-1-NAPHTHALENESULFONIC ACID] AND URANYL NITRATE-CALCON CARBOXYLIC ACID [3-HYDROXY-4-[(2-HYDROXY-4-SULFO-1-NAPHTHYL)AZO]-1-NAPHTHOIC ACID]. Mavrodin, Maria (Center of Inorganic Chemistry, Bucharest). pp 637-9 of Progress in Coordination Chemistry. /Cais, Michael (ed.). New York; American Elsevier Publishing Company, Inc. (1968). (In French).

From 11th International Conference on Coordination Chemistry, Haifa and Jerusalem, Israel. See CONF-680912-(Abstr.).

Spectrophotometric studies were made on the reactions and products of the systems. It was found that the relations of the formation of compounds are: UO_2^{2+}: Calcon = 1:2, and UO_2^{2+}: Calcon carboxylic acid = 1:2. The dissociation constants were found to be $\alpha = 0.19$; $K = 1.88 \times 10^{-11}$ for the compound formed in the uranyl nitrate-Calcon-water system and $\alpha = 0.16$; $K = 1.2 \times 10^{-11}$ for the compound formed in the uranyl nitrate-Calcon carboxylic acid-water system. The molar coefficients of extinction were 18,700 for the former system and 13,602 for the compound formed in the latter system. (P.C.H.)

9341 NEW COMPOUNDS OF THE URANYL ION WITH SOME PYRIMIDINE DERIVATIVES. Popea, Florica; Parlog, Constanta (Center of Inorganic Chemistry, Bucharest). pp 643-5 of Progress in Coordination Chemistry. /Cais, Michael (ed.). New York; American Elsevier Publishing Company, Inc. (1968).

From 11th International Conference on Coordination Chemistry, Haifa and Jerusalem, Israel. See CONF-680912-(Abstr.).

The preparation of solid compounds of uranyl ions with barbituric acid, thiobarbituric acid, and some 5-substituted derivatives of these two acids are reported. A compound was formed with 5-ethylbarbituric acid similar to that formed with unsubstituted barbituric acid. With 5-nitroso- and 5-nitrobarbituric acid compounds of the type ML_2 were formed. The physical properties, x-ray diffraction spectra, and ir spectra are reported for the 3 stable solid compounds. (B.L.M.)

9342 DIELECTRIC CONSTANT INVESTIGATION OF TBP-HEXANE SYSTEM. Petkovic, Djordje M. (Boris Kidric Inst. of Nuclear Sciences, Belgrade). pp 665-7 of Progress in Coordination Chemistry. /Cais, Michael (ed.). New York; American Elsevier Publishing Company, Inc. (1968).

From 11th International Conference on Coordination Chemistry, Haifa and Jerusalem, Israel. See CONF-680912-(Abstr.).

Self-association of TBP in the pure state or in TBP-aliphatic hydrocarbon systems was determined by (1) vapor pressure, (2) dielectric constant, (3) heat of mixing, and (4) distribution and ir measurements of the system. An equation is given, and treatment of the data obtained by measurement of the dielectric constants of dry TBP-hexane according to the equation led to a value of 2.7 ± 0.7 for the dimerization constant of TBP, which is in good agreement with the value obtained by ir measurements. Measurements were also made of the dielectric constants of TBP-CCl_4 and TBP-benzene systems. On the basis of these measurements, some discussion of the TBP dimer is presented. (B.L.M.)

9343 SPECTROSCOPIC STUDIES OF SOLVATION IN NONAQUEOUS SOLVENTS. Popov, Alexander I. (Michigan State Univ. East Lansing). pp 769-70 of Progress in Coordination Chemistry. /Cais, Michael (ed.). New York; American Elsevier Publishing Company, Inc. (1968).

From 11th International Conference on Coordination Chemistry, Haifa and Jerusalem, Israel. See CONF-680912-(Abstr.).

The spectra of a number of alkali metal salts (including those of NH_4^+) in the 5000 to 50 cm^{-1} spectral region were obtained in nonaqueous solvents including dimethyl sulfoxide (DMSO), dipropyl sulfoxide, dibutyl sulfoxide, 1-methyl-2-pyrrolidone, 2-pyrrolidone, TBP, and pyridine, as well as binary mixtures of some of these. In all cases a band was obtained in the 450 to 200 cm^{-1} region whose frequency was characteristic of the cation and the solvent but not the anion. The absorptions were always proportional to the concentrations of the cations. The spectra of solid solvates of alkali metal salts with DMSO of varying stoichiometries (1 to 4 DMSO/metal ion) were prepared and their spectra were found to be very similar to those obtained with the same salts in solution. A brief explanation of the spectral bands is included. (B.L.M.)

9344 A PREDICTION OF THE RELATIVE STABILIZATION OF THE HIGHER OXIDATION STATES OF Am IN SOLUTION. Yanir, E. (Soreq Nuclear Research Centre, Yavne, Israel); Marcus, Y.; Givon, M. pp 812-14 of Progress in Coordination Chemistry. /Cais, Michael (ed.). New York; American Elsevier Publishing Company, Inc. (1968).

From 11th International Conference on Coordination Chemistry, Haifa and Jerusalem, Israel. See CONF-680912-(Abstr.).

Literature on the complexibility of Am(IV), Am(V), and Am(VI) was surveyed. Condensed phosphates (particularly trimetaphosphoric acid) seem to be the most promising for stabilizing Am(IV) in addition to F^-, which was already known. Potassium pyrophosphate seemed to be very good for stabilizing Am(IV). Values of E, both calculated and experimental, for various oxidation couples are tabulated. (B.L.M.)

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Refer also to abstracts 9474-9477, 9479, 9481, 9696, 11153, and 11259.

9345 (NYO-2499-31) EFFECTS OF MERCAPTANS AND DISULFIDES ON PHOTOCHEMICAL AND HIGH-ENERGY RADIATION INDUCED REACTIONS. Progress Report, November 1, 1968-November 1, 1969. Cohen, Saul G. (Brandeis Univ., Waltham, Mass. Dept. of Chemistry). Contract AT(30-1)-2499. 21p. Dep. CFSTI.

The inhibition by mercaptan of the photoreduction of benzophenone by an optically active alcohol (2-octanol) was studied. Conditions for maximizing the hydrogen transfer mechanism were worked out. The photoreduction of the benzophenone–isoborneol and benzophenone–borneol systems were studied in the presence and absence of mercaptan. Gamma-radioinduced reactions in solutions of 0.1M 2-propanol in water were studied in the presence and absence of mercaptan as a function of pH. Yields of H_2, acetone, and pinacol were determined. Mercaptan greatly decreased the yield of acetone and pinacol. Experiments in D_2O indicate that protection involves transfer of H'(D') to the carbinol carbon. Mercaptan greatly enhanced formation of 2-propanol in radiolysis of aqueous acetone, in effect causing increased damage. Preliminary experiments were carried out on the radiolysis of aqueous solutions of 2-butylamine and of methyl acetate. The effects of various solvents on the isomerization of trans-stilbene in the irradiation of aminobenzophenones and benzophenone were studied. The addition of ~2N HCl or H_2SO_4 decreased the rate of photoreduction of benzophenone in 1:1 2-propanol–water to about one third its value in the absence of acid. Mineral acids also reduced intersystem crossing of benzophenone. (J.G.B.)

9346 (ORNL–4241) RECOVERY OF MULTIGRAM QUANTITIES OF ^{242}Cm AND ^{244}Cm IN THE CURIUM RECOVERY FACILITY. McDuffee, W. T.; Vaughen, V. C. A.; Kappelmann, F. A.; Whitson, W. R. (Oak Ridge National Lab., Tenn.). Dec 1969. Contract W-7405-eng-26. 93p. Dep. CFSTI.

The operation of the Curium Recovery Facility (CRF) over a 2.5-year period is described. Approximately 35 g each of ^{243}Am and ^{244}Cm were recovered from Savannah River Plant concentrate, and approximately 33 g of ^{242}Cm was recovered from irradiated $^{241}AmO_2$ targets. All of the ^{242}Cm and the fraction of the ^{244}Cm that was separated from the ^{243}Am were transferred to the Source Fabrication Facility for conversion into heat sources. The steps for purifying ^{242}Cm and ^{244}Cm included dissolution of the irradiated target material in HCl, separation and decontamination of the actinides from fission products and rare earths [employing the Clanex-Dapex-Tramex flowsheets, which feature amine-HCl and di(2-ethylhexyl) phosphoric acid as the extractants], conversion of the curium product streams to the nitrate system, and preferential precipitation of the pentavalent ^{243}Am as the sparingly soluble carbonate. About half of the ^{243}Am and ^{244}Cm processed in the CRF was recovered in the form of highly purified products; the remainder was stored for use in research and development. Typical product losses in solvent extraction were about 1%. Losses from decay (~0.5% per day) during ^{242}Cm processing were greater than the process losses. All of the final actinide products met purity and radiation specifications. Overall decontamination factors (DF's) of 10^3 for gross-gamma emitters were demonstrated; similar values were obtained for ruthenium and zirconium, while the cerium DF's of up to 300 were obtained under special reducing conditions. (auth)

9347 (ORO–2001–17) RADIATION INDUCED EFFECTS IN ORGANIC SYSTEMS. Progress Report, December 1, 1968–November 30, 1969. Johnsen, Russell H. (Florida State Univ., Tallahassee, Dept. of Chemistry). 15 Dec 1969. Contract AT(40-1)-2001. 14p. Dep. CFSTI.

Progress is reported on luminescent species in electron-bombarded organic vapors; energetic collisions of organic ions with charged metal surfaces, evidence for super excited states in the electron bombardment of organic vapors; radical decay kinetics in some irradiated amino acids; w-values using a fission fragment source, and charge exchange cross sections of methyl ions with inert gases. (D.H.M.)

9348 "CONGEALING" AND "REGENERATION" PHENOMENA OF POLYMER CHAINS DURING THE RADIATIVE POST-POLYMERIZATION OF THE LOW-TEMPERATURE POLYMORPHIC MODIFICATION OF SOLID ACRYLONITRILE. Kaplan, A. M.; Kiryukhin, D. P.; Barkalov, I. M.; Gol'danskii, V. I. Vysokomol. Soedin., Ser. B; 11: 639-41(Sep 1969). (In Russian).

The low-temperature polymorphic modification of acrylonitrile was exposed at 77°K to a 5-Mrad dose of γ radiation, the irradiated specimens maintained at 120, 143, and 156°K for specified periods, and then brought to room temperature. The yield of the polymer reached a limiting value, which increased with temperature. Comparison of the yield and molecular weight revealed that the number of polymer molecules during the post-polymerization period at a given temperature remained practically constant. This means that the post-polymerization process results in an increase of the chain length. The limiting value of the yield is therefore assumed to be related to the fact that a specific mean chain length, characteristic for the temperature has been reached. Studies with a diathermic calorimeter and chain-length measurements confirmed this theory concerning the freezing and regeneration of chains. This applies only for the polymerization of the solid monomer. (TTT)

9349 KINETICS OF HYDROGEN ISOTOPE EXCHANGE REACTIONS. PART XVI. AROMATIC EXCHANGE UNDER THE INFLUENCE OF β-RADIATION ON AQUEOUS SOLUTIONS OF MESITYLENE. Adsetts, J. R.; Gold, V. (King's Coll., London). J. Chem. Soc., B; No. 9, 1108-14(1969).

An uncatalyzed exchange reaction between water and mesitylene was observed in homogeneous solutions containing ca 4 curies of tritiated water per liter. The predominant reaction product was mesitylene labeled in the aromatic ring. The exchange rate depended on the second power of the tritium concentration, and the exchange was therefore attributed to the influence of the β radiation emitted by the tritium in solution. On the basis of the dependence of the exchange rate on the concentration of mesitylene and of added cupric and nickel ions, the exchange was considered to be initiated by attack of tritium atoms on mesitylene, leading to a methyl-substituted cyclohexadienyl radical as an intermediate. The results were incompatible with attack on mesitylene by solvated electrons as the initiating step. (auth)(UK)

9350 RADIOLYSIS OF O-CARBORANE IN BENZENE SOLUTION. Klingen, T. J.; Howard, M. Jr. (Univ. of Mississippi, University). Contract AT(40-1)-3781. Radiat. Res.; 40: 484-9(Dec 1969). (ORO–3781-2).

The radiolysis of 0.1 M o-carborane in benzene solution was investigated as a function of total dose and free radical scavengers. The only product obtained involving the carborane unit structure was 1-phenyl-o-carborane, with a $G = 0.43 \pm 0.02$ at a total dose of 4.49×10^{21} eV/ml. The production of 1-phenyl-o-carborane was essentially linear with total dose in the range 8.98×10^{20} to 6.28×10^{21} eV/ml. Free radical scavenging experiments indicated the mechanism for the formation of 1-phenyl-o-carborane is primarily of the free radical type. (auth)

9351 PULSE- AND GAMMA-RADIOLYSIS OF AQUEOUS SOLUTIONS OF TRYPTOPHAN. Armstrong, R. C. (Royal Military Coll. of Science, Wiltshire, Eng.); Swallow, A. J. Radiat. Res.; 40: 563-79(Dec 1969).

Absorbing transient species were formed by the reaction of ·OH, H·, and e^-_{aq} with tryptophan. The rate constants for the reaction of ·OH and H· with tryptophan were $1.25 \pm 0.3 \times 10^{10}$ M^{-1} sec^{-1} and $7.4 \pm 1 \times 10^9$ M^{-1} sec^{-1}, respectively. Hydroxyl radicals reacted largely by addition to the indole ring. The spectra were interpreted in terms of various reaction sites each giving rise to discretely absorbing isomers. Variations in the spectra under acid conditions were interpreted as due to protonation of the ·OH and H· adducts. The transients decayed by second order reactions giving further absorbing species. The rate constant for decay of trp-·OH was $2k = 7.7 \pm 0.9 \times 10^9$ M^{-1} sec^{-1} at pH 7. Similar rate constants were obtained for the other radicals derived from tryptophan. At pH 1 the H· and ·OH adducts decayed at the same rate with a composite rate constant, 2k, of $1.1 \pm 0.1 \times 10^9$ M^{-1} sec^{-1}. Gamma radiolysis of deaerated 2×10^{-2} M solutions at pH 1 gave $G(NH_3) = 0.51$, $G(H_2O_2) = G(RO_2H) = 0.63$, $G(H_2) = 0.37$, $G(CO_2) \sim 0$, $G(-trp) = 0.7$. The loss of tryptophan was also measured under various conditions and a mechanism has been proposed, involving recombination and the reactions of the radicals with the irradiation products, to account for the small loss of tryptophan in the gamma radiolysis of deaerated solutions. (auth)

9352 LOW PRESSURE ANOMALIES IN THE DOSIMETRY AND RADIOLYSIS OF GASES WITH HIGH INTENSITY ELECTRON PULSES. Boyd, A. W.; Armstrong, D. A.; Willis, C.; Miller, O. A. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Radiat. Res.; 40: 255-62(Nov 1969).

The product yields from HCl, HBr, and N_2O show large increases below 700 Torr when irradiated with electron pulses from a Febetron 705. At a dose rate of 10^{27} eV per gram second $G(H_2)$ from HCl and HBr increases by a factor of two between 700 and 100 Torr and $G(N_2)$ from N_2O increases by the same factor between 700 and 15 Torr. The efficiency of SF_6 as a scavenger for electrons is greatly reduced in N_2O and HCl at pressures of 50 and 120 Torr. The most coherent explanation of these low pressure anomalies is the acceleration of secondary electrons in transient electrical fields created by the Febetron pulse. It is clear that any dosimetry of these pulses and quantitative radiation studies at these high beam intensities must involve measurements of yields and studies of the effects of scavengers over a large pressure range. (auth)

9353 FORMATION OF POLYMER COATINGS ON SUBSTRATES. Williams, Terence; Hayes, Michael William (to British Iron and Steel Research Association). British Patent 1,168,641. 29 Oct 1969. Filed 19 May 1966.

A process for coating metal substrates is described. It comprises vapor deposition, under vacuum, of a material that can be crosslinked or polymerized by irradiation, and which has a vapor pressure at STP < 1 torr. The deposited material is irradiated to

produce crosslinking or polymerization, by the use of an accelerated electron beam, x rays, or γ rays. The coating material may compromise an epoxy resin or an uncured polyester resin. The coating process may be conducted in a continuous fashion. Various conditions for deposition and irradiation are mentioned. (UK)

9354 EFFECT OF TEMPERATURE ON RADIOLYSIS OF SOME ELASTOMERS. Kozlov, V. T.; Evseev, A. G.; Zubov, P. I. Vysokomol. Soedin., Ser A; 11: 2230-7(Oct 1969). (In Russian).

An increase in temperature in the radiolysis of elastomers SKTV = 0.5 "Viton" and of some of their vulcanizates, Kel-F, Nairit A and B, SKEP, EPT, NK, SKI-3, SKD, SKS-30, and SKMS-30 is accompanied with an increase in crosslinking and degradation; the latter usually is increased with higher rate. In EPT, SKEP, SKTV = 0.5 and SKI-3 at temperatures of 0.25 and 50°C, respectively, reversion of structuration was observed. In SKF radiation yields of crosslinking (G_c) and degradation barely changed in the whole temperature range. In SKS-30 and SKMS-30 $G_c \simeq 0.87$ at −196°C, but at 30°C G_c were equal to 2.2 and 1.1, respectively. The phenomena discovered are related to molecular structure of the elastomers. (auth)

9355 PULSE RADIOLYSIS OF AQUEOUS SOLUTIONS OF COBALT CYANIDE COMPLEXES. THE DETECTION OF PENTACYANOCOBALTATE(I) AND OTHER TRANSIENTS. Venerable II, Grant D. (Argonne National Lab., Ill); Hart, Edwin J.; Halpern, Jack. J. Amer. Chem. Soc.; 91: 7538-9(17 Dec 1969).

Some results of pulse radiolysis experiments on aqueous solutions of cobalt cyanide complexes are reported that include the direct detection of several important transient species, among them pentacyanocobaltate(I). Experimental conditions were maintained by scavenging and pH control so that essentially the only reaction species generated by the pulse radiolysis was e^-_{aq}. Pulse radiolysis experiments on aqueous solutions of $Co(CN)_5^{3-}$ ($\sim 10^{-5}$ M), in which the generation and decay of e^-_{aq} were followed at 578 nm revealed a reaction between e^-_{aq} and $Co(CN)_5^{3-}$, which obeyed the second-order reaction law, $k_1 \cdot [e^-_{aq}][Co(CN)_5^{3-}]$, with $k_1 = (1.4 \pm 0.1) \times 10^{10}$ M^{-1} sec^{-1}. The initial product of the reaction is a transient identified as pentacyanocobaltate(I) (λ_{max} 280 nm, $\epsilon_{max} \sim 8 \times 10^3$), which undergoes first-order decay ($k_2 = (1.0 \pm 0.1) \times 10^5$ sec^{-1}) to yield $Co(CN)_5H^{3-}$. In D_2O solution the k_1 was substantially the same as in H_2O, whereas the value of k_2 was reduced to 1.6×10^4 sec^{-1}. Pulse radiolysis experiments were also performed on aqueous solutions of various cobalt(III) cyanide complexes, including $Co(CN)_6^{3-}$, $Co(CN)_5OH^{3-}$, and $Co(CN)_5I^{3-}$. (D.H.M.)

9356 CHARGED STATES IN MOESSBAUER EFFECT AND HOT ATOM CHEMISTRY IN SOLIDS. Lebedev, V. A.; Babeshkin, A. M.; Nesmeyanov, A. N. Lamykin, E. V. Vestn. Mosk. Univ., Ser. II, Khim.; No. 5, 45-8(Sep-Oct 1969). (In Russian).

Studies were made in order to show that the charged states of hot atoms are stable beyond 10^{-6} sec and up to 1 min and that the charged states in nuclear gamma resonance and the material studied by hot atom chemistry of solids are identical. Moreover, it is shown that both nuclear gamma resonance and radiochemical methods may be used for studies of nuclear transformations. Irregular Moessbauer emission spectra of $Na_2H_4TeO_6$, H_6TeO_6, and frozen aqueous solutions of H_6TeO_6(^{125m}Te) are discussed in terms of hot atom chemistry. (R.V.J.)

9357 NUCLEAR γ-RESONANCE STUDIES OF THERMAL ANNEALING OF NEUTRON-IRRADIATED SnO. Babeshkin, A. M.; Bekker, A. A.; Efremov, E. N.; Nesmeyanov, A. N. Vestn. Mosk. Univ., Ser. II. Khim.; No. 5, 40-4(Sept−Oct 1969). (In Russian).

The retention of ^{119m}Sn increased upon annealing of neutron-irradiated SnO in helium at 300°C. At higher temperatures stannous oxide disproportionated giving SnO_2 and elementary Sn. (auth)

9358 THE EFFECT OF THE GLASS-TRANSITION TEMPERATURE OF CONVENTIONAL AND RADIATION-DEPOSITED POLYMERIC ADDITIVES ON MECHANICAL PROPERTIES OF COTTON FABRIC. Walsh, W. K.; Siahkolah, M. A.; Rutherford, Henry A. (North Carolina State Univ., Raleigh). Text. Res. J.; 39: 1126-34(Dec 1969).

The change in properties of cotton fibric produced by polymeric additives with varying degrees of stiffness or softness has been investigated by measuring these properties at different temperatures. It was concluded that changes in crease-recovery angle produced by these polymers were not due to lubrication but were related to the elastic-recovery properties of the added polymer. Changes in tear strength and abrasion resistance were found to be a function of interyarn mobility by measuring yarn withdrawal forces of the fabrics. Radioinduced deposition of polymers produced changes that were qualitatively similar to those made by conventional polymer applications, but the changes were not as pronounced. This was attributed to the lower degree of surface deposition and the lack of crosslinking of the radiation deposited polymers. (auth)

9359 RADIATION-INDUCED TRAPPED CHARGE CARRIERS IN ORGANIC POLYMERS. A MODEL OF THERMOELECTRIC CURRENT GENERATION. Barnes, J. E.; Hoecker, F. E.; Kevan, L. (Univ. of Kansas, Lawrence). Radiat. Res.; 40: 235-54(Nov 1969).

Trapping and detrapping of radiation-induced charge carries in poly-(methyl methacrylate) (PMMA), poly(vinyl chloride) (PVC), and several other polymers were investigated. Thermoelectric currents were generated in the polymers after irradiation by thermally stimulating the release of the trapped charges and subjecting them to a temperature gradient. Heating similarly irradiated samples in the absence of a temperature gradient produced a tenfold reduction in the observed current. The charge carriers were determined to be positive from the polarity of the colder electrode. To observe thermoelectric currents, electrons liberated during irradiation had to be trapped to prevent recombination with trapped positive charges. This trapping is not done by the polymer matrix of PMMA at 25°C but by added impurities. PVC contains a built-in trap in the polymer chain at the C−Cl group. The electron trap in commercial PMMA (Lucite) is benzoyl peroxide or another chemical initiator. Electron traps were also internally generated in pure PMMA polymer by radiation followed by heating to 120°C. (auth)

9360 ION CHEMISTRY OF SEVERAL C_6 MOLECULES IN THE GAS PHASE. Wexler, Sol; Pobo, Louis G. (Argonne National Lab., Ill.). J. Amer. Chem. Soc.; 91: 7233-41(17 Dec 1969).

Ion−molecule reactions in gaseous n-hexane, cyclohexane, methylcyclohexane, benzene, toluene, ethylbenzene, and aniline were studied at source pressures in the range from 0.025 to 1.00 Torr in a proton beam−high pressure mass spectrometer. Dimerization and in some cases trimerization involving parent and fragment positive ions were prominent reactions in the aromatic compounds, but they were not observed in the aliphatic molecules investigated. H^-, H_2^-, and charge transfer, as well as condensation reactions, occurred in both types of molecules. The observations are correlated with the results of previous radiation−chemical studies of these compounds to arrive at ionic mechanisms for their transformation to other substances under the action of a radiation field. (auth)

9361 RADIOLYSIS OF LIQUID ETHANOL–BENZENE MIXTURES IN THE PRESENCE OF ELECTRON SCAVENGERS. Holcman, J.; Karolczak, S.; Kroh, J.; Mayer, J.; Mienska, M. (Technical Univ., Lodz, Poland). Int. J. Radiat. Phys. Chem.; 1: 457-64(Nov 1969).

The radiolysis of the $C_2H_5OH-C_6H_6$ system in the presence of H_2SO_4 or N_2O was investigated. The deviations of this system from the additivity rule are caused by the reaction of benzene with solvated electrons and thermal H atoms, whose precursors are solvated electrons. The rate constants of the reaction of benzene with solvated electrons and H atoms are 5×10^6 and 3.9×10^8 l mol^{-1} s^{-1}, respectively. Hot hydrogen atoms produced in the reaction $C_2H_5OH \rightsquigarrow CH_3CHOH^+ + H + e^-$ do not react by addition to benzene. They form molecular hydrogen by abstracting H atoms from ethanol and possibly from benzene. (auth) (UK)

9362 IONIC PROCESSES IN THE RADIOLYSIS OF LIQUID BENZENE AS STUDIED BY TRITIUM SUBSTITUTION. Kroh, J.; Hankiewicz, E. (Technical Univ., Lodz, Poland). Int. J. Radiat. Phys. Chem.; 1: 451-6(Nov 1969).

The radioinduced production of tritiated products in benzene saturated with THO was investigated. Radical and excited state mechanisms of substitution were eliminated by previous experiments. Carbon tetrachloride markedly increased the yield of C_6H_5T production. The radiation yield of intermediates responsible for substitution is 0.077. These intermediates are probably benzene positive ions $C_6H_6^+$ and their yield agrees well with that of separated ion pairs as found by conductivity measurements. (auth) (UK)

9363 ESR STUDIES OF RADICAL FRAGMENTS PRODUCED IN X-IRRADIATED MONOSODIUM SUCCINATE AND DISODIUM MALONATE. Bales, Barney L. (Univ. of Colorado, Boulder); Schwartz, Robert N.; Hanna, Melvin W. J. Chem. Phys.; 51: 5178-80(1 Dec 1969).

ESR spectral studies of radical fragments in irradiated disodium malonate monohydrate were made to see whether the production of $HOOC\dot{C}H(CH_2)_nCOOH$ (I) is inhibited in this salt, relative to malonic acid. Also, results on irradiated monosodium succinate tetrahydrate are reported for the sake of completeness. The dominant

radical found in the two salts was I. Thus, it was concluded that the processes leading to I and $HOOC\dot{C}HCH_3$ are not a function of the absence or presence of carboxyl hydrogen atoms. This tends to support the supposition that the difference in the molecular packing scheme in succinic acid and its disodium salt is responsible for the different radiation damage behavior. (P.C.H.)

9364 OPTICAL-ABSORPTION SPECTRA OF KETYL RADICALS AND RADICAL ANIONS OF SOME PYRIMIDINES. Hayon, E. (Army Natick Labs., Mass.). J. Chem. Phys.; 51: 4881-92(1 Dec 1969).

The pulse radiolysis of aqueous solutions of various pyrimidines was studied under conditions where only solvated electrons are made to react with them. Transient optical-absorption spectra in the uv range were obtained which provide information on the site of e^-_{aq} on the pyrimidine molecule. These spectra were identified as the ketyl radicals of the C_2 and C_4 carbonyls, based on examination of substituted pyrimidine derivatives and making use of the keto–enol tautomerism which these molecules undergo. A pH 5.0 e^-_{aq} add at both the C_2 and C_4 positions, and the intermediates are rapidly protonated to give the corresponding ketyl radicals. The ketyl radicals dissociate to the corresponding ketyl radical anions with a pK ~ 7.0 to 7.5. In alkaline solutions, on ionization of one of the chromophores the ketyl radical anion of the other nondissociated carbonyl is formed. The ketyl radicals were found to have an extinction coefficient of ~1000 $M^{-1} \cdot cm^{-1}$ and to decay by a second-order process with $2k \sim 10^9\ M^{-1} \cdot sec^{-1}$. (auth)

9365 REACTION BETWEEN HYDRAZINE AND SODIUM IN LIQUID AMMONIA. Belloni, Jacqueline (Laboratoire Curie, Paris). Int. J. Radiat. Phys. Chem.; 1: 441-50(Nov 1969). (In French).

Previous results on the radiolysis of liquid ammonia were influential in making a study, on the possible role of the reaction $e^-_{am} + N_2H_4$; solutions of metallic sodium provided the source of ammoniated electrons. The room-temperature kinetic measurements led to the conclusion that this reaction is too slow to intervene in the radiolysis and that it occurs in two stages, the first being a slow dissociation of N_2H_4, behaving as a weak acid: $N_2H_4 + NH_3 \underset{k_{-1}}{\overset{k_1}{\rightleftharpoons}} N_2H_3^- + NH_4^+$ and the second, a very fast reaction: $e^-_{am} + NH_4^+ \xrightarrow{k_2} H + NH_3$. According to this mechanism it is found that: $k_2 = 3 \times 10^{-4}\ s^{-1}$ and $k_1/k_{-1} = 30$; the dissociation constant $[N_2H_3^-][NH_4^+]/[N_2H_4]$ in liquid ammonia would be 4×10^{-15} mole/l. H-atoms formed in the second stage do not destroy hydrazine in the presence of ammoniated electrons. (auth) (UK)

9366 RADIOLYSIS OF ISOPROPANOL AND WATER–ISOPROPANOL MIXTURES. Hecquet, M. F. (Faculte des Sciences, Bordeaux); Roux, J. C.; Simonoff, G. N.; Sutton, J. Int. J. Radiat. Phys. Chem.; 1: 529-40(Nov 1969). (In French).

The yields of solvated electrons in water–isopropanol mixtures of various compositions using the nitrate ion as scavenger were determined. The yields calculated from the formation of the nitrite ion and from the diminution of hydrogen were in satisfactory agreement. From the data obtained at high nitrate concentrations, it was concluded that the reactions between radicals in the zones of high ionization density are less important than foreseen by the spur diffusion theory. Calculated free ion electron yields confirm Freeman's hypothesis concerning the role of the dielectric constant of the medium. (auth) (UK)

9367 γ-RADIOLYSIS OF AQUEOUS HYDRAZINE SOLUTIONS. Belloni, Jacqueline; Haiessinsky, M. (Laboratoire Curie, Paris). Int. J. Radiat. Phys. Chem.; 1: 519-27(Nov. 1969). (In French).

The radiolysis of aqueous solutions of hydrazine was reinvestigated, in order to elucidate some aspects of the mechanism, especially the role of the radiolytic hydrogen peroxide and the influence of the pH, and also to determine the rate constants of the hydrazine reaction with H^+ and e^-_{aq} using competition with H_2O_2. If it is assumed that the radiolytic hydrogen peroxide, despite its weak stationary concentration, scavenges a part of the reducing radicals, the yields measured in acid and neutral media are in good agreement with the mechanism; namely $G(H_2) = G_{H_2} + G_{red} - G_{H_2O_2}$. The rate constant $k(N_2H_5^+ + H)$ was found to be 2.5×10^4 l $mole^{-1}\ s^{-1}$ at pH = 0 and 1.2×10^5 l $mole^{-1}\ s^{-1}$ at pH = 6; at the latter pH the rate constant $k(N_2H_5^+ + e^-_{aq})$ was about 1.5×10^7 l $mole^{-1}\ s^{-1}$. It seems that the small values of the radiolytic yields measured at pH = 13 are due to the slowness of the process $(N_2H_5^+ + e^-_{aq})$. (auth) (UK)

9368 PULSE RADIOLYTIC STUDY OF THE MIXED RADICAL-ANION COMPLEX $ClSCN^-$. Schoeneshoefer, M. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Int. J. Radiat. Phys. Chem.; 1: 505-13(Nov 1969). (In German).

In the pulse radiolysis of concentrated aqueous Cl^- solutions in the presence of small amounts of SCN^-, $ClSCN^-$ is observed. $ClSCN^-$ has a maximum absorption at 3900 Å with $\epsilon = 4.7 \times 10^3$ l $mole^{-1}\ cm^{-1} = 470\ m^2\ mole^{-1}$. It is in equilibrium with $(SCN)_2^-$: $ClSCN^- + SCN^- \rightleftharpoons Cl^- + (SCN)_2$. The equilibrium constant is 3.0×10^4. The constant of the dissociation equilibrium $ClSCN^- \rightleftharpoons SCN\cdot + Cl^-$ was found to be 1.5×10^{-1} mole l^{-1}. (auth) (UK)

9369 LUMINESCENCE KINETICS FOLLOWING PULSE IRRADIATION. IV. A PURINE PYRIMIDINE CRYSTAL COMPLEX. Lillicrap, S. C.; Fielden, E. M. (Inst. of Cancer Research, Sutton, Eng.). Int. J. Radiat. Phys. Chem.; 1: 479-93 (Nov 1969).

The behavior of the excited states formed after ionizing irradiation in a base-paired crystalline complex between 9-methyladenine and 1-methylthymine (AT complex) was studied by observing the associated luminescence. The luminescence spectra and decay kinetics of the AT complex and its separate components were observed over a temperature range of 93 to 300°K, and from 2 μsec to 1 sec after the start of a 1.6 μsec duration electron pulse. At low temperatures the early luminescence decay kinetics are complex and probably arise from trapping within the molecular or crystal structure. The major luminescence yields, however, arise from exponential portions of the decay curves. In this region the spectra and kinetics of the AT complex and the 1-methylthymine are closely similar, although the luminescence yield of the complex is much greater than that of the 1-methylthymine and is closer to the yield from 9-methyladenine. These results and results obtained at other temperatures were interpreted in terms of the transfer of excitation energy between the bases with emission occurring from the thymine base as is believed to occur in DNA. Possible mechanisms of energy transfer are discussed. (auth) (UK)

9370 METHOD FOR PRODUCING A COPOLYMER OF ETHYLENE TETRAFLUORIDE AND ETHYLENE. Oshima, Keiichi (to Industrial Res. Inst.). Japanese Patent 1969-19251. 21 Aug 1969. Filed 19 May 1965.

A high-yield method, which is easily controlled but which has an increased reaction velocity, is described for the production of a polymer from ethylene and tetrafluoroethylene. The product is produced in a form suitable for its industrial treatment, and high-yield, and variation in quality of the product is achieved by changing the mixing ratio. A hydrocarbon of fluorochloro system was added to a mixture of ethylene tetrafluoride and ethylene. Then, the whole condensation system below 10°C, is irradiated with ionizing radiation, to copolymerize the ethylene tetrafluoride and ethylene. The ionizing radiation may be neutrons, α, β, γ, or x rays. Ionizing radiation with energy as high as possible gives better results. (NSA of Japan)

9371 ELECTRON PARAMAGNETIC RESONANCE STUDIES OF RADIATION-DAMAGED SINGLE CRYSTALS. Schwartz, Robert Nelson. Boulder, Colo.; Univ. of Colorado (1969). 148p. Thesis.

Electron paramagnetic studies of x-irradiated single crystals of succinic acid, monosodium succinate tetrahydrate, and disodium malonate monohydrate were conducted in order to identify the fragments produced by ionizing radiation and to gain further insight into the nature of irradiation damage in dicarboxylic acids in the solid state. Analysis of the EPR spectra of room temperature x-irradiated disodium malonate monohydrate showed that only one radical is produced, namely, $^-OOC\dot{C}HCOO^-$. The principal values of the g-tensor (2.0039, 2.0035, 2.0028) and the α-proton coupling tensor (31 G, 20 G, 14 G) were typical of a π-electron radical. The crystal structure for this system was not available. However, since the EPR spectra displayed no site splitting, it was concluded that the unit cell was triclinic. The spectra of radiation damaged disodium malonate (single crystals) were measured immediately after x-irradiation at 77°K and while warming to higher temperatures. The principal fragment formed at 77°K was $\dot{C}H_2COO^-$. The spectra obtained from room temperature x-irradiated monosodium succinate tetrahydrate were characteristic of a fragment in which there is a magnetic coupling between the unpaired electron and three protons, two of which are magnetically equivalent at certain orientations. From the complete proton coupling tensors and the g-tensor, it was concluded that the principal long-lived paramagnetic species was $^-OOC\dot{C}HCH_2COO^-$. The data indicate that the plane containing the unsaturated carbon atom is nearly parallel to the plane of the adjacent carboxyl group. From the signs of the direction cosines of the principal axes of the g- and α-proton hyperfine tensors, it was concluded that monosodium succinate crystals are monoclinic. The room temperature paramagnetic species responsible for the single resonance line (enhanced by high microwave powers) at $g \simeq 2$ in room temperature x-irradiated succinic acid was shown to be $\dot{C}O_2^-$ rather than $^-OOCCH_2\dot{C}HCOO^-$ proposed by earlier workers. The principal values of the g-tensor were found to be $g_{11} = 2.0046$, $g_{22} = 2.0010$, $g_{33} = 1.9973$. In addition, controlled warming experiments on single crystals (the two acidic protons

replaced by deuterons) irradiated at 77°K have shown that the ionic species $HOOCCH_2CH_2\dot{C}OOH^-$, which is stable only at low temperatures, is most probably the precursor to the room temperature fragment $\dot{C}O_2^-$. (Diss. Abstr.)

9372 ELECTRON SPIN RESONANCE AND STRUCTURE OF THE BF_2 RADICAL. Nelson, William; Gordy, Walter (Duke Univ., Durham, N. C.). J. Chem. Phys.; 51: 4710-13(1 Dec 1969).

The BF_2 radical has been detected and its structure determined from observation of the electron spin resonance of γ-irradiated molecules of BF_3 trapped in the xenon matrix at 4.2°K. Hyperfine structure of both B and F was resolved and analyzed The isotropic coupling constants are: for ^{10}B, 277.98 Mc/sec; for ^{11}B, 826.24 Mc/sec; and for ^{19}F, 532 Mc/sec. Analysis of the hyperfine structure showed that the unpaired electron is in the σ system, that 93% of the electron spin density is in a nonbonding sp_2 hybrid on the B, and that the remaining 7% is in hybridized bonding orbitals of the two F atoms. The sp_2 hybrid of the unpaired electron on the B has 44% 2s character and 56% 2p character. This orbital is in the molecular plane. The bond angle derived from the hybridization is 112°. (auth)

9373 HYDROLYSIS OF SALICYL PHOSPHATE AND THE EFFECT OF BACKGROUND RADIATION ENERGY. Chang, Shuh-ming (Inst. of Chemistry, Taipei, Taiwan). Proc. Nat. Counc. Sci. Develop. Repub. China (Taiwan); No. 2, 199-206(Oct 1968).

The use of the hydrolysis of salicyl phosphate to salicylic acid and phosphoric acid as a reaction to measure background (e.g., cosmic) radiation was investigated. The reaction was studied in a lead-shielded chamber and in the presence of x radiation. It was assumed that hydrolysis of salicyl phosphate depends on 2 factors: one is the participation of the ortho-carboxyl group in the hydrolysis, the other is that phosphorus is capable of expanding its valence shell and thus becomes more susceptible to attack by a nucleophilic reagent. Owing to the attack of the oxygen of the carboxyl group upon the phosphorus, it forms a cyclic transition state and then decomposes to salicylic and phosphoric acids. Data obtained from the hydrolysis of salicyl phosphate in different pH buffer solutions in a wooden box, in a lead box, or exposed to x rays are shown. Results revealed that the rate of the hydrolysis of salicyl phosphate in the lead box is greater than that in the wooden box after elapse of the same time interval. The more radiation energy absorbed by the reaction mixture, the less salicyl phosphate is hydrolyzed. Actually, the rate of the hydrolysis of salicyl phosphate in the lead box was greatest while that exposed to x rays was least. The rate of hydrolysis of salicyl phosphate at pH 3.3 or 2.85 was less than that at pH 5.2, in agreement with a previous hypothesis. (BBB)

9374 MECHANISM OF THE RADICAL FORMATION BY RADIOLYSIS OF AROMATIC COMPOUNDS IN THE SOLID PHASE. Buben, N. Ya.; Chkheidze, I. I. Mendeleev Chem. J.; 11: 173-9(Mar-Apr 1966).

Free radicals formed in low-temperature radiolysis of some simple aromatic compounds were studied. The characteristic triplet with field splitting of 90 Oe in irradiated benzene is due to the C_6H_7 radical. The radiolysis of benzene was compared with experiments on the production of C_6H_7 radicals by the reaction of benzene with atomic hydrogen from a gas discharge that produced an identical ESR spectrum. The similarity of the ESR spectra of irradiated alkylbenznes, thiophenol, aniline, and anisole was due to the C_6H_6R-type radicals formed as a result of the combination of atomic hydrogen with a double bond of the ring. The fraction of such radicals is 50% in benzene and 30% for its homologs. In benzene and biphenyl practically complete combination between H atoms and the ring is characteristic; abstraction of H from the molecule is rare. In the radiolysis of alkylbenzenes and biphenyls the spectra are complicated. For phenol and other similar compounds in which radical pairs are formed at a small distance from each other the limiting concentrations of radicals are 5×10^{18} to 3×10^{19}/g and are achieved at doses of 300 to 500 Mrad. For benzene, biphenyl, their homologs, sodium phenoxide, and anisole, where a more equal distribution of radicals throughout the sample is found, the limiting concentrations of radicals are higher: 1 to 5×10^{18}/g and are attained at doses of 1 to 3×10^3 Mrad. (BBB)

9375 STUDY OF THE WOOD-PLASTIC COMBINATIONS BY USE OF GAMMA RADIATION. Wang, Ung-ping (Ministry of Economic Affairs, Taipei, Taiwan). Proc. Nat. Counc. Sci. Develop. Repub. China (Taiwan); No. 2, 177-94(Oct 1968). (In Chinese).

Styrene, methyl methacrylate, and vinyl acetate were polymerized in situ in Taiwan cypress and cedar wood. The products of such wood–plastic combinations were found to be superior to the native woods because of: (1) homogeneity of the density of the resulting materials; (2) increased hardness and enhanced compressibility to the range of 16 to 21 kg/cm²; (3) reduced water absorption, not exceeding 20% of the weight of wood–plastic combinations; (4) resistance to weather as well as antimolding and anticracking stability; and (5) resistance to termite attack. The fundamental aspects of the relation between total dose and polymer conversion and between polymerization rate and dose rate were investigated and are discussed in detail. When monomers that contained the vinyl radical were polymerized in the natural, deoiled, and preirradiated wood materials, it was found that the equation for the polymerization-rate could be expressed, from experimental results, as $V = 10^a \cdot R^{k/2}$, where V is the polymerization rate, a and k are constants, and R is the dose rate. Low-grade grafting of monomer radicals onto the wood cellulose was also confirmed. The theoretical polymerization-rate equation for this type of reaction was also derived on the basis of the free radical polymerization mechanism, as $V = [(k_p)\ (k)^{1/2}/(k_t)^{1/2}] \cdot R^{1/2} \cdot [M]$, where k_p, k_t, and k are the reaction-rate constants and [M] is the concentration of monomer. From the experimental results it was concluded that the polymerization rate is proportional to the square root of the dose rate and this finding was in accord with the theoretical equation. (BBB)

9376 RADICALS FORMED IN THE RADIOLYSIS OF CERTAIN TETRACHLORO COMPOUNDS. Magat, M.; Leray, H.; Roncin, J. (Univ. de Paris, Orsay, France). Mendeleev Chem. J.; 11: 168-72(Mar-Apr 1966).

The ESR spectra of irradiated CCl_4, $SiCl_4$, and $SnCl_4$ were compared. The samples were γ irradiated (^{60}Co) in sealed quartz ampules with a dose from 1 to 100 Mrad, at 1 Mrad/hr in most cases. The spectra designated A to C of the compounds and the changes induced by warming were similar. A detailed description of the results for CCl_4 irradiated at 77 and 178°K is given. Specific differences observed for the other compounds are described. In CCl_4 irradiation produces several radicals, which are distinguished by their temperature stability. Only the correspondence between spectrum B and XCl_3 radical is established. The correspondence between spectrum B_2 and XCl^* radical, first suggested in connection with the radiolysis of CCl_4 and $SiCl_4$, is probable. The existence of spectra A, B_3, and C, indicates the presence in irradiated tetrachlorides of paramagnetic ionic centers. Only C is assigned to the Cl_3^- ion. (BBB)

9377 RECLAIMING OF DIAPHRAGM RUBBERS FROM BUTYL RUBBER BY THE ACTION OF IONIZING RADIATIONS. Tarkhov, G. V.; Blokh, G. A.; Meleshevich, A. P. (Inst. of Physical Chemistry, Kiev. Dnepropetrovsk Chemical Tech. Inst., USSR). Khim. Prom. Ukr., No. 2, 20-1(Mar.-Apr. 1969). (In Russian).

The reclaiming of diaphragm resins of butyl rubber was achieved under the action of high-energy ionizing radiations (25 to 50 MRAD). The optimum dose was 50 MRAD. Additions of radiation-reclaimed rubber to various diaphragm rubbers had almost no effect on the physicomechanical properties of the rubbers, but the thermal properties were improved. (JPRS)

9378 GAMMA RADIOLYSIS OF CRYSTALLINE UREA. Renoult, D. H.; McCallum, K. J.; Woods, R. J. (Univ. of Saskatchewan, Saskatoon, Can.). Int. J. Radiat. Phys. Chem.; 1: 495-503(Nov 1969).

Products formed by the γ-radiolysis of crystalline urea are, in order of decreasing G value, H_2NCHO, H_2, $H_2NCO-NH-CONH_2$, N_2, NH_3, $H_2NCO-NH-NH-CONH_2$, $H_2NCO-NH-NH_2$ and $H_2NCO-CONH_2$; G(-urea) = 0.53. The yields appear to be independent of the presence of oxygen and of absorbed dose. Energy dissipation and radical caging are believed to be facilitated by the highly hydrogen-bonded structure of the crystals and to account for relatively low G(product) values. Product yields and the mass spectrum of urea suggest that radiation causes predominantly C–N bond fission; a radiolysis mechanism is proposed. Radiolysis of the 1-iodohexane-urea inclusion compound gives a greater yield of iodine than radiolysis of pure 1-iodohexane. For the inclusion compound $G(I_2)$ is independent of absorbed dose. (auth) (UK)

9379 RADIOLYSIS OF THIOPHENOL AND BENZYL MERCAPTAN. Simonidze, M. Sh.; Panchvidze, M. V.; Nanobashvili, E. M. (Inst. of Inorganic Chemistry and Electrochemistry, Tbilisi, USSR). Soobshch. Akad. Nauk Gruz. SSR; 56: 333-6(Nov 1969). (In Russian).

The radiolysis of thiophenol and benzyl mercaptan by the action of γ rays was investigated. Primary and intermediate products of radiolysis were identified by the methods of EPR and infrared spectroscopy. General regularities of radiation-chemical transformation of thiophenol and benzylmercaptan were established. (auth)

9380 RADIATION-CHEMICAL OXIDATION OF AQUEOUS THIOCARBAMIDE SOLUTIONS. Ivanitskaya, L. V.; Nanobashvili, E. M.; Ratiani, M. G. (Inst. of Inorganic and Electrochemistry, Tbilisi, USSR). Soobshch. Akad. Nauk Gruz. SSR; 56: 337-40 (Nov 1969). (In Russian).

The radiation-chemical transformation of aqueous thiocarbamide solutions by the action of γ rays, depending on the solute concentration, dose rate, and vapor saturation, was studied. Certain regularities in the radiation-chemical oxidation of aqueous thiocarbamide solutions were established. (auth)

9381 INVESTIGATIONS BY ^{19}F BROADLINE MAGNETIC RESONANCE. Cyr, Theodore James Raymond. Vancouver, B. C.; Univ. of British Columbia (1968).

Thesis.

A detailed study of the ^{19}F nuclear magnetic resonance (NMR) spectra of KPO_2F_2 is presented. The temperature dependence of the second moment and line width is interpreted in terms of reorientation of the $PO_2F_2^-$ anion in the crystal lattice. A detailed analysis of the line shape at low temperatures is used to yield the interatomic spacings of the PF_2 fragment in the $PO_2F_2^-$ anion. An investigation of the NMR adiabatic rapid passage technique as a quick and simple method for determining nuclear Zeeman spin-lattice relaxation times, T_1 was carried out. The limitations of the experiment are examined and correction formulas are presented. A ^{19}F nuclear magnetic resonance investigation of polycrystalline K_2NbF_7 and K_2TaF_7 yielding some of the kinetics of molecular motion was carried out. The crystal structures were found to be essentially identical. An investigation of the ^{19}F NMR spectra of paramagnetic RhF_5 and IrF_5 was reasonably successful in elucidating the molecular configuration of these substances. A brief examination of the electron spin resonance spectra of x-irradiated polycrystalline KPO_2F_2 and Na_2PO_3F was carried out. Two anion radicals, PO_3^- and PO_2F^-, were identified and, within certain approximations, the nearly isotropic hyperfine coupling constants evaluated and interpreted in terms of unpaired electron spin densities at the magnetic nuclei. A discussion of each set of data is included, and interpretation of the data is given. (Diss. Abstr.)

9382 ZERO-FIELD ELECTRON MAGNETIC RESONANCE SPECTRA OF RADICALS DERIVED FROM SOME AMINO ACIDS. Birkle, M. (Univ., Karlsruhe, Ger.); Schoffa, G.; Lefebvre, R.; Oliver, G. J. Magn. Resonance; 1: 666-76(Nov 1969).

The zero-field electron magnetic resonance spectra of electron-irradiated powders of glycylglycine, carbamylglycine, glycocyamine, and acetylglycine all present six broad bands that are readily interpreted as resulting from the interaction of the electron magnetization with the proton left at the damaged site in the molecule. High field studies have shown that in such radical species there is also a weaker coupling with a neighboring nitrogen nucleus. Simulated spectra were used to study the effect of this additional coupling and to derive corrected values of the components of the coupling tensor of the proton, which are believed to be more accurate than those obtained at high field. (auth)

9383 PREPARATION OF $^{234}Th(UX_1)$ BY DISTRIBUTIVE CHROMATOGRAPHY. Shestakov, B. I.; Shestakova, I. A.; Moskvin, L. N. Radiokhimiya; 11: 471-3(1969). (In Russian).

A simple and rapid method is proposed for the systematic production of trace amounts of $UX_1(^{234}Th)$ by distributive reverse-phase chromatography. The method permits simultaneous separation of iron impurities present in the uranium. (M.C.G.)

9384 THE CHEMICAL CONSEQUENCES OF NUCLEAR TRANSFORMATIONS IN COMPOUNDS OF TIN, IRON, AND COBALT, STUDIED BY MOESSBAUER AND RADIOCHEMICAL METHODS. Murin, A. N.; Bondarevskii, S. I.; Seregin, P. P. Radiokhimiya; 11: 474-7(1969). (In Russian).

Isomeric transitions and K capture were studied in neutron-irradiated compounds of cobalt, iron, and tin by nuclear gamma resonance. (M.C.G.)

9385 FREE RADICALS IN GAMMA-IRRADIATED 2-DEOXY-D-RIBOSE: ELECTRON SPIN RESONANCE OF SINGLE CRYSTALS AND POLYCRYSTALLINE MATERIAL. Huettermann, Juergen; Mueller, Adolf (Kernforschungszentrum, Karlsruhe, Ger.). Radiat. Res.; 38: 248-59(May 1969).

Single crystals of 2-deoxy-D-ribose were studied by electron spin resonance (ESR) spectroscopy at 8-mm wavelength following γ-irradiation. The main feature of the spectra recorded was a quintet pattern of about 10 gauss hyperfine splitting. The splitting as well as the mean g factor of 2.005 was found to be almost independent of crystal orientation. Minor spectral variations were attributed to the presence of other radicals. This conclusion was proved by observation of ESR spectra from irradiated polycrystalline 2-deoxy-D-ribose at 8-mm and 3-cm wavelengths. Heat-treatment of these samples revealed the presence of at least two other radicals. The quintet pattern is attributed to interaction of a radical electron at a carbon atom with four β-protons bound to neighboring carbon atoms in radicals $COOHCH_2CHOH\dot{C}OHCH_2$, which are assumed to be produced by rupture of a CO bond following initial dissociation of atomic hydrogen. The proposed reaction scheme is discussed as a model for the initial processes of chain ruptures in DNA. (auth)

9386 LUMINESCENCE FROM TRYPSIN IN THE DRY STATE AND IN SOLUTION DURING IRRADIATION WITH X-RAYS AND ULTRAVIOLET LIGHT AT 77°K. Steen, H. B. (Norsk Hydro's Inst. for Cancer Research, Montebello, Norway). Radiat. Res.; 38: 260-73(May 1969).

The luminescence of trypsin in an ethylene glycol–water solution and in the dry state, as obtained during irradiation with x-rays and ultraviolet light in vacuum at 77°K, was compared to that observed for L-tryptophan and L-tyrosine in a similar solution under the same conditions. The emission spectra of the x-ray-induced luminescence in the trypsin samples were similar to those excited by 270-nm uv light, except that in the former case the phosphorescence was greatly enhanced relative to the fluorescence. The spectra of trypsin, both in the dry state and in solution, resembled that of tryptophan, although in solution tyrosine appeared to give rise to about 10% of the phosphorescence for the two types of irradiation. For the dry trypsin no contribution from tyrosine could be detected. These results were supported by the decay pattern of the phosphorescence of the protein, which was largely similar for x-rays and uv light. It was concluded that the luminescence was due to the same excited levels with both types of irradiation. The enhanced phosphorescence-to-fluorescence ratios, observed with x irradiation, prompted the proposition that, in addition to excitation directly from the ground state, ion–electron recombination gives rise to excitation of the radiative levels in this case. The relative importance of the two types of excitation was evaluated. Comparison of the emission yields for trypsin in solution and in the dry state with those of tryptophan and tyrosine in solution indicated that there was no significant contribution to the x-ray-induced luminescence of trypsin from energy transfer, either intermolecular or between solvent and solute. (auth)

9387 RADIATION-INDUCED FREE RADICALS IN FROZEN NITRIC ACID SOLUTIONS. Loekkevik, Per; Henriksen, Thormod (Norwegian Radium Hospital, Montebello, Norway). Radiat. Res.; 38: 231-47(May 1969).

Radiation-induced free radicals in frozen aqueous solutions of nitric acid were studied by the electron spin resonance technique in both H_2O and D_2O. The observed resonance spectra at 77°K provide evidence for the formation and stabilization of NO_2, NO_3, and NO_3^{2-} radicals. Heat-treatments show that NO_3 and NO_3^{2-} disappear rapidly at temperatures above 200°K, whereas the NO_2 radicals are very stable and can be observed at temperatures almost up to the melting point of the solutions. The quantitative measurements reveal that radicals are stabilized in extremely large yields in these solutions. The yield-versus-concentration curves are parabola-shaped, with a maximum at about 12 M. The G values at maximum for the different types of solutions range from 12 to 17, which implies that only 6 to 8 eV of absorbed radiation energy is sufficient to induce a radical. The implication of the direct and indirect action of radiation in frozen solutions is discussed, as well as the significance of the trapping mechanisms. For the more concentrated solutions (above 6 M) both polycrystalline and glassy or amorphous samples were used. The largest number of radicals is observed for the glassy samples. The difference in the yield of trapped radicals between crystalline and amorphous samples may be due either to differences in the trapping conditions or to differences in the efficiency of the indirect action of radiation. (auth)

9388 ELECTRON SPIN RESONANCE OF GAMMA-IRRADIATED SINGLE CRYSTALS OF 9-METHYLADENINE. Schmidt, Jack; Snipes, Wallace (Pennsylvania State Univ., University Park). Contract AT(30-1)-3799; NGR 39-009-008. Radiat. Res.; 38: 274-84(May 1969).

Irradiation of 9-methyladenine at room temperature produces two stable free radicals, one by a hydrogen addition reaction at either C-2 or C-8 of the purine ring, and one by a hydrogen abstraction reaction from the methyl group. The hydrogen abstraction radical is analyzed in detail by using electron spin resonance (ESR) spectroscopy. Hydrogen hyperfine interactions with the two protons have principal values, in gauss, of $A_x^{H(1)} = 10.5$, $A_y^{H(1)} = 30.0$, $A_z^{H(1)} = 18.5$, $A_x^{H(2)} = 8.5$, $A_y^{H(2)} = 32.5$, and $A_z^{H(2)} = 19.5$. The principal values for the hyperfine interaction with N-9 are $A_x^N = 3.5$, $A_y^N = 3.9$, and $A_z^N = 3.0$. In nondeuterated

crystals, an additional hyperfine splitting due to the C-8-H proton is observed at some orientations. The g tensor is axially symmetric, with $g_{||} = 2.0021$ and $g_{\perp} = 2.0029$. Some effects of observation temperature on the ESR spectra are also reported. (auth)

9389 CELLULOSE GRAFT COPOLYMERS. I. GRAFT COPOLYMERIZATION OF ETHYL ACRYLATE WITH γ-IRRADIATED CELLULOSE FROM METHANOL-WATER SYSTEMS. Nakamura, Yoshio; Hinojosa, Oscar; Arthur, Jett C. Jr. (Dept. of Agriculture, New Orleans). J. Appl. Polym. Sci.; 13: 2633-41(Dec 1969).

Ethyl acrylate was graft-copolymerized with γ-irradiated, purified cotton cellulose from methanol-water systems. The accessibility of the free radicals in the irradiated cellulose to water, methanol, ethyl acrylate, and methanol-water solutions was determined by electron spin resonance spectroscopy. The maximum scavenging of the radicals was recorded when the irradiated cellulose was immersed in methanol-water solution, which had a composition of 50/50 vol-%. When ethyl acrylate was added to methanol-water solution (50/50 vol-%), maximum grafting on the irradiated cellulose occurred at a concentration of ethyl acrylate of about 20 vol-%. As the concentration of ethyl acrylate was decreased, maximum grafting occurred in solutions containing less than 50 vol-% methanol. It was also noted that maximum grafting of ethyl acrylate in methanol-water solutions to irradiated cellulose occurred at boundary conditions, that is, conditions where the ternary mixture was still one phase, slightly different from compositions which caused the mixture to separate into two phases. From methanol solution, maximum grafting occurred at a concentration of ethyl acrylate of 80 vol-%. The extent of grafting from methanol was less than that obtained from methanol-water solutions at lower concentrations of ethyl acrylate. The accelerative effects of water were considered to be due to the Trommsdorff effect. (auth)

9390 DIRECT PREPARATION OF POROUS POLYETHYLENE FILTERS BY RADIATION POLYMERIZATION OF ETHYLENE. Okada, Minoru; Takehisa, Masaaki; Machi, Sueo; Danno, Akibumi (Japan Atomic Energy Research Inst., Takasaki). J. Appl. Polym. Sci.; 13: 2657-63(Dec 1969).

In order to prepare porous, macroscopically homogeneous filters without a separate packing process, ethylene was polymerized by radiation in glass tubes. The bulk density of the polyethylene is approximately proportional to $\bar{\rho}_M(\bar{f}_M)^{3}I^{0.3}t^{3}$, where $\bar{\rho}_M$ is average ethylene density, $\bar{f}_M$ is average ethylene fugacity, I is radiation dose rate, and t is reaction time. The effect of the bulk density on "treatment capacity" was investigated by experiments where air samples containing 0.1 wt-% iodine vapor were filtered. Treatment capacity is defined as that amount of air per gram of polyethylene which passes through a filter until the polyethylene reaches the break point. The treatment capacity is approximately constant at 9×10^{3} cm^3/g over the bulk density range from 0.03 to 0.07 g/cm^3, and it is lower at the outside of this range. The pressure drop due to the polyethylene filters varies with the 2.7th power of the bulk density when the bulk density is more than 0.03 g/cm^3; below 0.03 g/cm^3 this exponent increases with decreasing bulk density. Because of both the necessity of high treatment capacity and that of low pressure drop, the optimum bulk density of polyethylene in the filter is about 0.03 g/cm^3. (auth)

9391 ELECTRON BEAM IRRADIATION OF AN ULTRA-HIGH-MOLECULAR-WEIGHT POLYETHYLENE RESIN IN AIR. Brenner, W. (New York Univ., N. Y.); Adler, A.; Oswald, H. J.; Turi, E. A. J. Appl. Polym. Sci.; 13: 2689-97(Dec 1969).

High molecular weight linear polyethylene was irradiated in the solid state by high energy electrons. The irradiated samples were characterized by differential scanning calorimetry, solubility properties, and stress-strain measurements. A failure mechanism is proposed for the observed embrittlement of the polymer. (auth)

9392 EFFECT OF OXYGEN ON INTENSITY EXPONENTS OF RADIATION-INDUCED POLYMERIZATION RATES. Tsurugi, Jitsuo; Fukumoto, Tsugio; Yamagami, Masayuki (Radiation Center of Osaka Prefecture, Sakai, Japan). J. Appl. Polym. Sci.; 13: 2705-19(Dec 1969).

Gamma radiation-induced graft polymerization to natural rubber in benzene solution (solution grafting), graft polymerization to natural rubber latex (emulsion grafting), and emulsion polymerization of three vinyl monomers [styrene (St), methyl methacrylate (MMA) and acrylonitrile (AN)] were carried out under air atmosphere to compare the radiation intensity exponent of each polymerization rate under air atmosphere with that under nitrogen atmosphere or under vacuum. The intensity exponents of the solution grafting both under air atmosphere and under exclusion of air were found to be numerals near one half. This indicates prevailing normal radical mechanism. However, the intensity exponents of the emulsion grafting under air atmosphere were found to be 0.94, 1.00, and 0.82 for St, MMA, and AN, respectively, and those of the emulsion polymerization under air atmosphere, 0.16 and 0.15 for St and MMA, respectively, although those of both emulsion grafting and emulsion polymerization under exclusion of air were found to be numerals near to one half except for that of emulsion polymerization of AN. For emulsion grafting, the initiating species is considered to be trunk polymer radical but the terminating species is assumed to be the radical(s) produced in the water phase in the presence of oxygen. For emulsion polymerization, both initiating and terminating species are assumed to be the radical(s) produced in the water phase in the presence of oxygen. (auth)

9393 THE RADIOLYSIS OF AQUEOUS SOLUTIONS OF FREMY'S SALT: RATE CONSTANTS FOR THE REACTIONS WITH SOLVATED ELECTRONS AND HYDROGEN ATOMS. Moreau, M.; Schmidt, M.; Sutton, J. (CEN de Saclay, Gif-sur-Yvette, France). Int. J. Radiat. Phys. Chem.; 1: 433-40(Nov 1969).

The effects of Fremy's salt ($K_2NO(SO_3)_2$) (the anion $NO(SO_3^-)_2$ is denoted by F) in aqueous solution on the γ radiolytic yield of molecular hydrogen, GH_2 and also the kinetics of the competition between F and $H_2PO_4^-$ for the solvated electron yield, Ge^-_{aq}, and between F and $HCOO^-$ for the hydrogen atom yield, GH, are reported. From the results the following rate constants are deduced, corrected for ionic strength effects: $k(e^-_{aq} + F) = (1.82 \pm 0.5) \times 10^9$ l mol^{-1} s^{-1}, $k(H + F) = (3.0 \pm 0.5) \times 10^9$ l mol^{-1} s^{-1}. The salt effect corrections are discussed in detail and, although the corrected rate constants are shown to be lower than the calculated diffusion controlled rates, the possibility that these reactions are diffusion controlled cannot be definitely excluded. Under conditions of ionic strength ≈0.2 mol l^{-1} at pH 6.25 to 8.5 the values $Ge^-_{aq} = 2.45 \pm 0.1$ (corrected for contributions from intraspur processes), $GH = 0.57 \pm 0.05$ and $GH_2 = 0.42$ are obtained; these values are discussed with reference to other recent work. (auth) (UK)

9394 EFFECT OF PARAMAGNETIC IONS ON THE RADIATION RESISTANCE OF CHELATE COMPLEXES. van de Vorst, Albert (Univ., Liege). Int. J. Radiat. Phys. Chem.; 1: 515-17(Nov 1969). (In French).

The yields of the radiolytic decomposition of chelate complexes irradiated in the solid state by x and γ radiations were determined at 100 and 300°K. They are compared with the yields characteristic of their organic constituents irradiated under the same conditions. The results obtained demonstrate that the paramagnetism of the central ion manifests itself in an enhancement of the radioresistance of the complex. (auth) (UK)

9395 ELECTRON SPIN RESONANCE OF TWO RADICALS FORMED IN X-IRRADIATED CYANOACETYLUREA, ANOTHER SIGMA-ELECTRON RADICAL OF THE RCONH TYPE. Lau, P. W.; Lin, W. C. (Univ. of British Columbia, Vancouver). J. Chem. Phys.; 51: 5139-42(1 Dec 1969).

Two radical species were formed when cyanoacetylurea $CNCH_2CONHCONH_2$ crystals were irradiated with x rays. One was a π-electron radical, $CN\dot{C}HCONHCONH_2$, and the other a σ-electron radical, $CNCH_2CONHC\dot{O}NH$. The latter was found to have similar hyperfine coupling tensors as H_2NCOCH_2CONH, which was formed in x-irradiated malonamide, and the former as $CN\dot{C}HCOOH$, which was formed in γ-irradiated cyanoacetic acid. (auth)

9396 THE EFFECT OF ELECTRON, POSITIVE ION, AND HYDROGEN ATOM SCAVENGERS ON THE YIELDS OF ATOMIC AND MOLECULAR HYDROGEN IN THE RADIOLYSIS OF LIQUID CYCLOHEXANE. Asmus, K.-D.; Warman, John M.; Schuler, Robert H. (Carnegie-Mellon Univ., Pittsburgh). J. Phys. Chem.; 74: 246-57(22 Jan 1970).

Electron scavengers are found to depress the hydrogen yield from the γ irradiation of cyclohexane by an amount approximately equivalent to the yield of scavenged electrons. It is concluded that in pure cyclohexane neutralization of the positive ions by electrons yields hydrogen with near unit efficiency but that little hydrogen is produced when neutralization occurs with secondary negative ions. A somewhat lower efficiency is noted for hydrogen production from positive-ion electron neutralization in other hydrocarbons, particularly the more highly branched ones. Cyclopropane solutions also show a decrease in hydrogen production which is equivalent to the yield of products from secondary positive-ion reactions. Little hydrogen is produced from the solute. In the case of ethylene as a solute both positive-ion reactions and hydrogen atom scavenging appear to be responsible for decreases observed in the hydrogen yield. Production of ethyl radicals was studied in considerable detail and from effects of cyclopropane and electron scavengers on their yield it is concluded that the hydrogen atom yield from pure cyclohexane is ~1.5. This hydrogen atom yield is, however, depressed by the presence of either elec-

tron or positive-ion scavengers so that a somewhat lower value is appropriate to cases where solutes are present. Equations are given which are based on the empirically observed concentration dependence for ion-scavenging processes and which quantitatively describe the atomic and molecular yields of hydrogen from the various solutions. (auth)

9397 PHOSPHORESCENCE YIELDS AND RADICAL YIELDS FROM PHOTOLYSIS OF TETRAMETHYL-p-PHENYLENEDIAMINE IN 3-METHYLPENTANE GLASS CONTAINING ALKYL HALIDES. French, William G.; Willard, John E. (Univ. of Wisconsin, Madison). Contract AT(11-1)-1715. J. Phys. Chem.; 74: 240-5(22 Jan 1970).

The yields of alkyl radicals produced from alkyl halide solutes by dissociative electron capture ($RX + e^- \rightarrow R + X^-$) during photoionization of tetramethyl-p-phenylenediamine (TMPD) in 3-methylpentane (3MP) glass at 77°K decrease in the order RCl > RBr > RI. The analogous radical yields from radiolysis of RX in 3MP are not dependent on the halogen. Phosphorescence yields and lifetimes indicate that the reductions in radical yields from the iodides and bromides in the TMPD system result from the formation of TMPD-RX complexes in which the lifetime of the TMPD triplet state is reduced. Shortening of the triplet state lifetime lowers the probability of the two-photon photoionization process. The phosphorescence yields with and without CH_3I present indicate a $[TMPD\text{-}CH_3I]/[TMPD][CH_3I]$ ratio in the glass at 77°K of 760. These data help to explain earlier observations on the effect of methyl iodide on the electrical conductivity of solutions of photoionized TMPD in 3MP glass during warmup from 77°K. Additional observations include (1) the rate of production of free radicals in the TMPD system is proportional to the second power of the light intensity, as expected; (2) CH_3F undergoes dissociative electron capture in 3MP at 77°K, although such dissociation with thermal electrons is endothermic in the gas phase; and (3) the ratio of yields of CH_3, C_2H_5, and C_3H_7 from dissociative electron capture by the corresponding chlorides, using electrons from the photoionization of TMPD, is 1.00:1.25:1.75, rather than decreasing with increasing carbon number as reported earlier. (auth)

9398 WHITE RESIDUE RELEASED FROM IRRADIATED POLYTETRAFLUOROETHYLENE BY HEAT TREATMENT. Tutiya, Mituaki (Tokyo Metropolitan Inst. for Radiological Research, Fukazawa, Japan). Jap. J. Appl. Phys.; 8: 1356 (Nov 1969).

The white residue released from irradiated PTFE by heat treatment was analyzed for a gamma-ray dose of 1.1×10^9 R. Its infrared spectrum shows two strong bands at 1150 and 1210 cm^{-1}, indicating fluorine compounds with $-CF_2^-$ structure. The ^{19}F NMR shows two lines, one broad and one narrow. Needle-shaped products in the residue exhibit a x-ray diffraction pattern fitting the [100] reflection of PTFE. The results indicate shortened, rod-like molecular chains of low molecular weight. (D.L.C.)

9399 INVESTIGATIONS OF THE SZILARD–CHALMERS EFFECT IN PHENYLARSENIC COMPOUNDS: INFLUENCE OF THE IRRADIATION CONDITIONS. PART 1. MONOPHENYLARSENIC COMPOUNDS. Grossmann, G. (Technische Univ., Dresden). Isotopenpraxis; 5: 262-7(Jul 1969). (In German).

The compounds $PhAsO(OH)_2$, $(PhAsO)_n$, $(PhAs)_5$, and $PhAsH_2$ were irradiated at different neutron fluxes, intensities of gamma radiation and temperatures in vacuum or in the presence of air. A thermal treatment (annealing) occurs in many cases. The distribution of radioactive arsenic atoms on products with different number of phenyl groups per arsenic atom was determined. The following problems are discussed: activity distribution resulted by primary and secondary effects; change of the diffusion-controlled secondary effects by oxygen as a radical scavenger; tertiary processes running off by the thermal annealing; quaternary effects from gamma rays. For $PhAsO(OH)_2$, $(PhAsO)_n$, $(PhAs)_5$, and $PhAsH_2$ the sum of primary and secondary retention (yield of PhAs-products) is 16.1; 24.5; 23.8 and 18.8%, respectively. (auth)

9400 THE PRIMARY REPLACEMENT ISOTOPE EFFECT IN RECOIL TRITIUM REACTIONS WITH ISOBUTANE. Small, Thomas; Rowland, F. S. (Univ. of California, Irvine). Contract AT(11-1)-34. J. Phys. Chem.; 74: 456-63(22 Jan 1970).

The primary replacement isotope effect for the substitution of T atoms for H or D atoms in hydrocarbons was measured as 1.25 ± 0.05 through comparison of recoil tritium reactions at the tertiary position in $(CH_3)_3CH$ vs. $(CH_3)_3CD$ and $(CD_3)_3CH$ vs. $(CD_3)_3CD$. The increased yield for replacement of H vs. D is suggested to result from the more rapid response of H atoms to changes in chemical binding during the interactions of the butane molecules with energetic T atoms. The isotope effect in the abstraction of H vs. D from the tertiary position in isobutane is 1.65 ± 0.06. Alkyl substituent effects, including steric hindrance, are essentially absent in gas phase experiments with $i\text{-}C_4D_{10}$ (R = 0.96; R = tertiary T per bond/primary T per bond) and small with $i\text{-}C_4H_{10}$ (R = 0.87). A gas/liquid phase effect is observed which reduces the liquid phase value of R by 15 to 25%. (auth)

9401 RECOIL TRITIUM REACTIONS IN METHANE–HYDROGEN MIXTURES. CD_4–H_2. Root, John W.; Rowland, F. S. (Univ. of California, Davis. Univ. of California, Irvine). Contracts AT(11-1)-407; AT(11-1)-34. J. Phys. Chem.; 74: 451-5(22 Jan 1970).

The variations in absolute yield of HT, DT, and CD_3T were studied over the entire range of mole fractions for CD_4-H_2 mixtures. The specific activity of CD_3T/CD_4 increases at high CD_4 mole fractions, while that of HT/H_2 is almost constant for all composition. These specific activity changes imply that an appreciable amount of HT-forming reaction occurs below the threshold for CD_3T formation. No combination of reactivity integrals and α factors were found that will simultaneously fit all binary mixtures involving CH_4, CD_4, H_2, and Ar. (auth)

9402 RECOIL TRITIUM REACTIONS WITH 1-BUTENE AND 1-BUTENE-1,1-d_2 IN THE GAS PHASE. Lee, Edward K. C.; Rowland, F. S. (Univ. of California, Irvine). Contracts AT(11-1)-407; AT(11-1)-34. J. Phys. Chem.; 74: 439-45(22 Jan 1970).

Energetic tritium atoms were treated with 1-butene and 1-butene-1, 1-d_2 over a range of pressures, and in competition with n-butane. The primary mechanisms of formation of ethylene and propylene from 1-butene are demonstrated by isotopic labeling to be, as expected, the decomposition of excited n-butyl and sec-butyl radicals formed in the addition of tritium to the olefinic positions. In each case, a lesser mechanistic route also exists to the formation of the smaller olefins. The decomposition of both excited butyl radicals is pressure dependent, with a larger effect for sec-butyl radical indicative of its formation by lower energy tritium atoms. An isotope effect in the yield of propylene from sec-butyl-t* is found, favoring lesser decomposition of the radical formed by terminal addition to $=CD_2$ than to $=CH_2$. The formation of $CH_2=CHT$ from $T^* + CH_3CH_2CH=CD_2$ is attributed to high excitation energy decomposition of 1-butene-t. The tritium-labeled parent molecules formed by substitution of T-for-H show pressure-dependent yields for both butenes and for n-butane-t. The yield of T-for-CH_3 per position is probably higher for CH_3 in 1-butene than CH_3 in n-butane. Detailed comparison of product yields in mixtures with those from single-component systems indicates competition between abstraction and addition in the 1 to 3 eV range. (auth)

9403 STEREOCHEMISTRY OF ENERGETIC CHLORINE ATOM EXCHANGE IN ALKYL HALIDES. Wai, Chien M.; Rowland, F. S. (Univ. of California, Irvine). Contract AT(11-1)-34. J. Phys. Chem.; 74: 434-8(22 Jan 1970).

Energetic chlorine atoms produced in nuclear recoil substitute for Cl atoms in either meso- or dl-2,3-dichlorobutane with almost complete (≥93%) retention of configuration at the asymmetric centers in the gas phase. The same result is obtained for hot chlorine atoms from the nuclear reactions $^{37}Cl(n,\gamma)^{38}Cl$ and $^{40}Ar(\gamma,p)^{39}Cl$. (auth)

9404 PREPARATION OF CARRIER-FREE ^{62}Zn FOR MEDICAL USE. Thakur, M. L.; Nunn, A. D. (Hammersmith Hospital, London). Radiochem. Radioanal. Lett.; 2: 301-6 (27 Dec 1969).

A detailed account is given of the method of preparation of ^{62}Zn, as $ZnCl_2$ for medical use. The radiozinc is produced by the α particle bombardment of Ni, through the $^{60}Ni(\alpha,2n)^{62}Zn$ reaction. The method of etching the target after bombardment is described. Ion exchange is used for separation of zinc; 70% acetone in 0.3 M HCl is found an efficient eluant. (auth)

9405 THE ROLE OF OXYGEN TRACES IN THE RADIOLYSIS OF GASEOUS ETHYLENE. Niedzielski, J.; Gawlowski, J. (Univ. of Warsaw). Radiochem. Radioanal. Lett.; 2: 291-9 (27 Dec 1969).

The effects of oxygen traces on the distribution and yields of stable products from radiolysis of gaseous ethylene were examined as a function of the initial oxygen concentration. It was found that oxygen greatly affects not only free radical reactions, but to a much greater degree ionic processes, owing to proton transfer from positive ions to compounds containing oxygen, such as acetaldehyde or ethanol. (auth)

9406 VAPOR-PHASE GRAFT COPOLYMERIZATION OF VINYL CHLORIDE AND VINYLIDENE CHLORIDE ONTO POLYPROPYLENE FIBERS BY SIMULTANEOUS IRRADIATION TECHNIQUE. Kawase, Kaoru; Hayakawa, Kiyoshi (Government

Industrial Research Inst., Nagoya, Japan). J. Polym. Sci., Part A-1; 7: 3363-74(Dec 1969).

The vapor-phase graft copolymerization of vinyl chloride and vinylidene chloride onto polypropylene fibers was studied by a simultaneous γ-irradiation technique. The weight increase during irradiation due to the grafting in monomers at constant vapor pressure was measured by a sensitive spring balance. The sorption of both monomers onto unirradiated polypropylene fibers was also measured. The graft copolymerization reaction was suppressed with increasing irradiation temperature, and the overall activation energies of grafting were negative in both monomers, −2.4 kcal/mole for vinyl chloride and −6.3 kcal/mole for vinylidene chloride. The initial rate of grafting increased linearly with the vapor pressure of monomers. The above dependence was found to parallel the sorption of monomers on polypropylene fibers. The reaction rates were proportional to the 0.9 power of the dose rate in both monomers. The relationship between the grafting and the sorption of monomers was discussed on the basis of kinetics. (auth)

9407 RECOIL TRITIUM REACTIONS WITH 1,3-DIMETHYLCYCLOBUTANE. ESTIMATES OF ENERGY DEPOSITION FOR THE T-for-CH_3 AND T-FOR-H REACTIONS. Ting, C. T.; Rowland, F. S. (Univ. of California, Irvine). Contract AT(11-1)-34. J. Phys. Chem.; 74: 445-50(22 Jan 1970).

More than 96% of the methylcyclobutane-t molecules formed by T-for-CH_3 substitution in 1,3-dimethylcyclobutane undergo secondary decomposition in gas-phase experiments, implying that these substitution reactions usually leave 6 to 7 eV excitation energy with the product molecule. Secondary decomposition of the labeled parent molecule, formed by T-for-H substitution, is observed both in gas (25%) and liquid (12%) phases. Decomposition occurs after either ring- or alkyl-hydrogen atom replacement, with only small positional differences in fractional decomposition. Substitution in the tertiary C−H position is ≥95% stereospecific with retention of configuration. Primary substitution of T-for-H is 0.93 ± 0.04 as likely, per C−H bond, in ring positions as in the alkyl groups. (auth)

9408 THE RADIOLYSIS OF LIQUID NITROGEN CONTAINING HYDROCARBONS. I. ETHYLENE AND PROPYLENE. Oka, Takefumi; Suda, Yoshikazu; Sato, Shin (Tokyo Inst. of Tech.). Bull. Chem. Soc. Jap.; 42: 3083-7(Nov 1969).

The γ-radiolysis of liquid nitrogen containing ethylene and propylene was investigated. As the nitrogenous products, hydrogen cyanide (0.18) and acetonitrile (0.04) were observed in the case of ethylene, and acetonitrile (0.12), in the case of propylene. The values in the parentheses are the G-values estimated on the basis of the energy absorbed by liquid nitrogen. In order to elucidate the mechanism of the reaction between nitrogen atoms and propylene, the mixture of C_3H_6 and C_3D_6 and the $CD_3CH=CHD$ compound were also used as solutes. The acetonitrile obtained was mainly CH_3CN and CD_3CN in the former case, and CD_3CN in the latter. These results suggest that a nitrogen atom produced in the system attacks the carbon atom in the middle of propylene and produces acetonitrile, leaving a methyl radical, the carbon atom in which was originally attached to the double bond. (auth)

9409 CHEMICAL EFFECTS OF THE NUCLEAR PROCESS $^{187}Re(\gamma,n)^{186}Re$ IN MIXED CRYSTALS $K_2ReBr_6-K_2SnCl_6$. Mueller, Horst (Univ., Freiburg i.B.). pp 189-90 of Progress in Coordination Chemistry. Cais, Michael (ed.). New York; American Elsevier Publishing Company, Inc. (1968).

From 11th International Conference on Coordination Chemistry, Haifa and Jerusalem, Israel. See CONF-680912-(Absts.).

The nuclear reaction $^{187}Re(\gamma,n)^{186}Re$ was carried out in homogeneous mixed crystals $K_2ReBr_6-K_2SnCl_6$. After dissolution of the irradiated crystals the ^{186}Re activity was found in the form of the mixed hexabromochlororhenates, $^{186}ReBr_nCl_{6-n}^{2-}$ ($0 \le n \le 6$). The separation was carried out by ionophoresis and ionic exchange on diethylaminoethylcellulose paper. Due to the large recoil range of ca. 100 Å, the recoil Re atoms leave the environment of their 6 original Br ligands. The halogenorhenates are produced in nearly the expected statistical amounts. The results also indicated the true homogeneity of the mixed crystals. (B.L.M.)

9410 RADIATION STABILITY OF AMINE EXTRACTANT SYSTEMS. Baroncelli, F.; Gasparini, G. M.; Grossi, G. (CNEN-CSN, Rome). pp 731-4 of Progress in Coordination Chemistry. /Cais, Michael (ed.). New York; American Elsevier Publishing Company, Inc. (1968).

From 11th International Conference on Coordination Chemistry, Haifa and Jerusalem, Israel. See CONF-680912-(Absts.).

The stability of high-molecular-weight tertiary alkylamines subjected to high doses of ionizing radiation was investigated in the presence of HNO_3. The chemical stability, effect of total radiation dose, effect of HNO_3, effect of amine concentration, influence of dose rate, and influence of the presence of U(VI) in the organic phase were studied. The extent of degradation was found to be proportional to the total dose absorbed and to the initial concentration of free organic HNO_3. Initial amine concentration of the amine in the diluent does not affect the extent of degradation for amine concentrations of 0.18 to 0.74M. Negligible differences in amine degradation were noted for dose rates of 0.2 to 0.8 MRad/hr. Concentrations of U(VI) of 1 to 6g/l did not affect the degradation. Extent of degradation seemed to be unaffected by NO and NO_2 in the organic phase before irradiation. (B.L.M.)

9411 KINETIC ISOTOPE EFFECT IN THE RADIATION-INDUCED DECOMPOSITION OF CRYSTALLINE POTASSIUM NITRATE. Ladov, Edwin N.; Johnson, Everett R. (Univ. of Maryland, College Park). J. Amer. Chem. Soc.; 91: 7601-6 (31 Dec 1969).

A kinetic isotope effect in the radiolysis of crystalline $KN^{18}O_3$ was observed, which has a maximum of 19 ± 3% at an absorbed dose of 0.5×10^{21} eV/g. The isotope effect is explained by the simultaneous occurrence of two reaction paths that produce an additive isotope effect. One of these paths involves an exciton-induced reaction of randomly diffusing oxygen molecules at preferred lattice sites. The amount of decomposition occurring via this reaction path is a function of the concentration of these "preferred" sites, which in the case of most inorganic solids is on the order of 10^{17} to 10^{19} per cm^3. The other reaction path is that associated with direct decomposition of excited or ionized nitrate ions. (auth)

9412 RADIATION-INDUCED INTERCONVERSION OF ACETONE-^{14}C AND 2-PROPANOL-^{14}C. Burr, John G.; Goodspeed, F. C. (North American Rockwell Corp., Thousand Oaks, Calif.). J. Amer. Chem. Soc.; 91: 7671-4(31 Dec 1969).

The yield of 2-propanol-^{14}C (IPA*) in γ-irradiated mixtures of acetone-2-^{14}C (Ac*) and 2-propanol (IPA) is a bimolecular function of the Ac* and IPA concentrations. The maximum yield is 6.9 in an equimolar mixture of components and is the same at −196 as to 40°C. The yield of Ac* in irradiated mixtures of IPA* and acetone (Ac) is also a bimolecular function of the component concentrations, with a maximum yield of 4.6 in an equimolar mixture. This conversion process is more strongly affected by temperature, and the maximum yield is lower at −196°C than at 40°C. Neither one of these interconversion reactions could be induced by 313-nm uv light, and the yields of γ-induced 2-butene isomerization in IPA and in Ac were relatively low. These interconversions are interpreted in terms of the various possible reactions of acetone anion (formed by electron capture) and 2-propanol cation (formed by the ionizing radiation). (auth)

Radiochemistry

Refer also to abstracts 9484, 9765, and 10200.

9413 NATURAL URANIUM AND ITS RADIATION. Chorvat, Dusan. Prac. Lek.; 21: 371-3(Oct 1969). (In Czech).

A short account is given of basic physical parameters, (energy of gamma rays, value of gamma emission constant, energy of beta particles) characterizing the radiation of natural uranium. Factors capable of influencing the emission rate in the environment of a reactor fuel element are considered. A linear source with self absorption is assumed. (auth)

9414 THE EFFECT OF INTERNAL IRRADIATION ON POLYMORPHIC TRANSITIONS IN Cm_2O_3. Kapshukov, I. I.; Sudakov, L. V.; Rykov, A. G.; Yakovlev, G. N. Radiokhimiya; 11: 465-6(1969). (In Russian).

The effects of self-irradiation from ^{244}Cm on polymorphic transitions in Cm_2O_3 were studied. The starting material was a mixture of CmO_2 and Cm_2O_3 prepared by sintering curium oxalate in oxygen at 650°C. (M.C.G.)

9415 STUDIES USING RADIOISOTOPES. II. HYDROXYLATION-INDUCED MIGRATION OF TRITIUM DURING THE BIOSYNTHESIS OF FUROQUINOLINE ALKALOIDS. Hall, C. R.; Prager, R. H. (Univ. of Adelaide). Aust. J. Chem.; 22: 2437-41(Nov 1969).

(4-T)Anthranilic acid has been synthesized and administered to Acronychia baueri. The furoquinoline alkaloids skimmianine and acronidine have considerable residual radioactivity, but acronycidine is only feebly radioactive. A partly specific "N.I.H. shift" is postulated and its implication to the order of introduction of hydroxyl groups in vivo is discussed. (auth) (Australia)

Separation Processes

Refer also to abstracts 9232, 9251, 9277, 9294, 9335, 9563–9565, 9567, 9570, 9628, 9648, 10145, 11104, and 11199.

9416 (A-AC-82/G/L-1287) STUDY OF THE KINETICS OF CESIUM ION DESORPTION FROM THE CESIUM FORM OF VERMICULITE. Kokotov, Yu. A.; Ivanova, S. R. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow). 1969. 9p. (In Russian). Dep. CFSTI (U. S. Sales Only).

Curves for the kinetics of the desorption of microquantities of cesium from vermiculite by calcium, sodium, and potassium salt solutions were analyzed from the point of view of the theory of diffusion. Evaluation of the values of the interdiffusion coefficients for the Cs–Ca system and the initial interdiffusion coefficient for the Cs–K system revealed a strong difference in the sorptive capacities of these systems. Considerable differences in the initial rate of sorption and desorption of microquantities of cesium and the appearance of false equilibrium during cesium adsorption by vermiculite were observed in the experiment. (R.V.J.)

9417 (ANL-7603) METHOD FOR THE PURIFICATION OF MOLTEN CHLORIDE SALTS. Johnson, T. R.; Teats, F. G.; Pierce, R. D. (Argonne National Lab., Ill.). Aug 1969. Contract W-31-109-eng-38. 20p. Dep. CFSTI.

A simple, effective method was developed for purifying molten mixtures of the chlorides of alkali metals and alkaline earths, particularly those containing magnesium chloride. Such salt mixtures are used as process solvents in proposed pyrochemical processes for the recovery of spent fast reactor fuel. In the purification method, the molten salt is contacted with a Mg–Cd alloy at temperatures near 600°C under an inert atmosphere. After at least 10 hr of agitation the salt is allowed to settle for several hours and is then filtered through a sintered metal filter. Metallic impurities are reduced by the magnesium metal and are extracted into the metal phase. Oxides, hydroxides, and water react with magnesium to form hydrogen and MgO, which is insoluble in the salt. Salt that was treated in this manner contained less than 0.2 wt % oxygen as MgO. The concentrations of metallic impurities such as Fe, Ni, Cr, Mn, and Ag were less than 100 ppM. The treated salt was not corrosive toward ferrous, nickel, or certain refractory metal alloys, and it formed stable solutions with chlorides of lanthanides and actinides. Apparatus to treat 80 kg batches of chloride salts was assembled, and was used to purify over 1000 kg salt that met the requirements of purity for a variety of engineering and chemistry experiments related to the development of pyrochemical processes. (auth)

9418 (BARC-397) LABORATORY INVESTIGATIONS ON DIRECT CHLORINATION VOLATILITY PROCESSING OF NUCLEAR FUELS. PART I. PROCESS FLOW SHEETS, THERMOCHEMICAL, AND VOLATILITY DATA ON CHLORIDES. Sood, D. D.; Hariharan, A. V. (Bhabha Atomic Research Centre, Bombay (India)). 1969. 30p. Dep. CFSTI (U. S. Sales Only).

Direct chlorination volatility methods are considered for the processing of thorium-based and uranium-based nuclear reactor fuels. In these methods a hydrochlorination or chlorination step would be utilized for the head-end treatment of fuel materials. The fuel materials are then converted to chlorides by reaction with chlorine gas saturated with carbon tetrachloride at moderate temperatures. Separation of the fuel, matrix, and fission product chlorides is achieved by selective volatilization of the chlorides. Typical flow sheets for application of direct chlorination volatility methods to reprocess ThO_2–UO_2 and UO_2–PuO_2 type fuel materials are discussed. The physical and thermochemical properties of chlorides pertinent to the process are also included. (auth)

9419 (BARC-404) LABORATORY INVESTIGATIONS ON DIRECT CHLORINATION VOLATILITY PROCESSING OF NUCLEAR FUELS. PART II. CHLORINATION OF URANIUM OXIDES. Sood, S. P.; Balakrishnan, P. V.; Prasad, Rajendra; Hariharan, A. V. (Bhabha Atomic Research Centre, Bombay (India)). 1969. 32p. Dep. CFSTI (U. S. Sales Only).

The chlorination of uranium oxides with chlorine gas saturated with carbon tetrachloride was studied for its application to direct chlorination volatility processing of nuclear fuels. Chlorination of UO_2 and U_3O_8 with Cl_2–CCl_4 gas proceeds at satisfactory rates in the temperature range 350 to 500°C. In general UO_2 chlorinates at a lower rate than U_3O_8 in this temperature range. The reaction products are essentially volatile UCl_5 and UCl_4. Experiments were performed to determine the feasibility of using refractory fused alumina as a high-temperature packed-bed filter medium in the chlorination process. Chlorination of U_3O_8 mixed with sodium chloride at 450 to 600°C proceeds with the formation of UCl_4, which forms a stable complex with NaCl. The volatility of uranium chlorides from an NaCl matrix is negligible at temperatures up to 600°C. Volatile UCl_6 may be condensed and collected on a high-surface-area alumina filter bed at room temperatures. Granular NaCl was observed to absorb volatile uranium chlorides in the process off-gas. The retention of uranium chlorides is quantitative in NaCl sorption beds at temperatures of 250 to 300°C. Uranium is sorbed as UCl_5 in NaCl sorption beds at these temperatures. Hydrogen gas reduces UCl_5 in NaCl matrix to nonvolatile UCl_4 in NaCl at 500 to 600°C. This step would facilitate gas-solid reactions to be performed on uranium chlorides absorbed in NaCl to separate volatile fission product chlorides. (auth)

9420 (BARC-405) LABORATORY INVESTIGATIONS ON DIRECT CHLORINATION VOLATILITY PROCESSING OF NUCLEAR FUELS. PART III. SEPARATION OF THORIUM AND URANIUM FROM ThO_2–UO_2 AND PROCESSING IRRADIATED FUEL MATERIALS. Sood, S. P.; Sood, D. D.; Rengan, K.; Hariharan, A. V. (Bhabha Atomic Research Centre, Bombay (India)). 1969. 31p. Dep. CFSTI (U. S. Sales Only).

Chlorination of sintered ThO_2–UO_2 solid solution with Cl_2–CCl_4 was studied for the separation of thorium and uranium from oxidic nuclear fuels. The effect of several factors such as chlorination temperature, period and composition of Cl_2–CCl_4 chlorinating medium, use of carbon-chlorine as an alternate chlorinating agent and chlorination of single pellets of ThO_2–UO_2 were investigated in detail. The use of refractory alumina packed bed filters permitted efficient condensation and separation of $ThCl_4$ from volatile UCl_5–UCl_6 in the chlorination-separation process. The volatile uranium chlorides were absorbed in a subsequent NaCl sorption bed at 250 to 300°C. Separation factors for thorium in uranium were of the order of 10^3 to 10^4 in small-scale laboratory experiments. The behavior of typical major fission products (Zr, Nb, Mo, Cs, Ru, Ce, and Eu) and protactinium in the optimized chlorination-separation flow-sheet for ThO_2–UO_2 fuel materials was studied in some detail. The order of magnitude of the decontamination factors for fission products and protactinium in the $ThCl_4$ retention zone and uranium chloride sorption zone in the primary chlorination step was determined. A series of experiments were performed with irradiated ThO_2–UO_2 to separate and purify the thorium and uranium fractions from fission products and protactinium. After the primary chlorination step, the thorium fraction ($ThCl_4$) was redistilled at 675 to 700°C in Cl_2–CCl_4 gas stream. The uranium fraction (UCl_5 in NaCl) was pyrohydrolyzed, oxidized, and rechlorinated at 500°C. Overall decontamination factors for purified $ThCl_4$ were 4.10^4 (Gross γ), 4.10^3 (Gross β), 9.10^2 (Ce), $>10^3$ (Ba,Ru) and $>10^4$ (Zr,Nb,Pa). The decontamination factors for purified uranium fractions were 34 (Gross γ), 69 (Gross β), 10^4 (Ce,Ba), $3.2.10^2$ (Zr), $>10^3$ (Nb) and 51 (Pa). (auth)

9421 (BNWL-1263) RESEARCH AND DEVELOPMENT ACTIVITIES, FIXATION OF RADIOACTIVE RESIDUES. Quarterly Progress Report, August–October 1969. Blasewitz, A. G. (ed.) (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Dec 1969. Contract AT(45-1)-1830. 33p. Dep. CFSTI.

Twenty-six radioactive demonstrations in WSEP were completed with simulated wastes containing approximately 38 MCi of mixed radionuclides being converted to solids. Approximately 6.2 MCi of radioactivity were successfully processed in three phosphate glass solidification runs in WSEP. A simulated Purex Waste 4m (PW-4m) was processed during all three runs and was the first radioactive demonstration of the phosphate glass process with this waste. In the final run, a heat rate density of 315 W/liter was attained in the product. This is equivalent to that which would result from solidifying waste from the reprocessing of power reactor fuel aged 0.25 years. A simulated PW-4m waste was solidified during a developmental spray solidifier run in which the calcined waste was fluxed to a semivitreous solid in the waste storage container. In another developmental run, a simulated fast reactor waste was solidified, and the process scheme appears suitable for demonstration with the WSEP spray solidifier. Gas sampling techniques that were initiated will permit better definition of the type, form, and extent of radioactivity in the process off gas from the solidifiers. Environmental testing of waste containers in the Solids Storage Engineering Test Facility was initiated with testing of waste containers from WSEP Runs SS-4 and PG-6. (auth)

9422 (DOCKET-50201-21) [WEST VALLEY REPROCESSING PLANT]. Environmental Report, January–September 1967. (Nuclear Fuel Services, Inc., West Valley, N. Y.). 24 Jan 1968. 20p. Dep. CFSTI.

9423 (DOCKET-50201-22) [WEST VALLEY REPROCESSING PLANT]. Environmental Report No. 3, September–December 1967. (Nuclear Fuel Services, Inc., West Valley, N. Y.). 25 May 1968. 20p. Dep. CFSTI.

9424 (DOCKET-50201-23) [WEST VALLEY REPROCESSING PLANT]. Environmental Report No. 4, January–June 1968. (Nuclear Fuel Services, Inc., West Valley, N. Y.). 8 May 1969. 18p. Dep. CFSTI.

9425 (DOCKET-50201-24) [WEST VALLEY REPROCESSING PLANT]. Environmental Report No. 5, July–December 1968. (Nuclear Fuel Services, Inc., West Valley, N. Y.). 8 May 1969. 20p. Dep. CFSTI.

9426 (DOCKET-50201-25) [WEST VALLEY REPROCESSING PLANT]. Environmental Report No. 6, January–June 1969. (Nuclear Fuel Services, Inc., West Valley, N. Y.). 1 Dec 1969. 12p. Dep. CFSTI.

9427 (EUR–4401) ZETA POTENTIAL CONTROL APPLIED TO THE TREATMENT OF RADIOACTIVE EFFLUENT. Gillot-Stokkink, A. J.; Lopes Cardozo, R. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). 3 Sep 1969. 46p. Dep. CFSTI (U. S. Sales Only).

Studies were carried out to improve working conditions in the decontamination plant for radioactive effluent at Ispra. This plant operates by a scavenging-flocculation process. The generally applied but unprecise "beaker tests" used for sedimentation control were completed by precise measurements of the surface charge or zeta potential of the radioactive sludge suspensions. This allowed the exact choice of appropriate reactants and dose rates for optimum flocculation in the case of each type of effluent to be treated. Zeta potential measurements were performed with a commercialized device called "Zeta-meter," comprising a Riddick-type electrophoresis cell. The use of a cationic polyelectrolyte flocculant, such as the Purifloc C 31 of Dow Chemicals, gave very satisfying results. Its application in the decontamination plant produced excellent and stable settling conditions, which resulted in doubling the previously obtained process rates. (auth)

9428 (EURAEC–2088) REPROCESSING OF IRRADIATED FUELS. Final Report. (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)). 8 Apr 1969. Contracts 006-65-7-RCIB; 016-65-1-RAPB. 116p. (EUR–4009). Dep. CFSTI.

Work performed under United States–Euratom Joint Research and Development Program.

Highlights from basic and conceptual studies and cold and hot technology experiments are presented. The reaction mechanism of ClF_3 and ClF with UO_2-PuO_2 mixtures was investigated as a function of temperature and gas and fuel composition. The decreasing sphere model can be applied to the ClF_3 reaction, which also takes place at high speed even with $(U-Pu)O_2$ solid solutions. The monofluoride (ClF) on the contrary can be considered as a selective fluorinating agent for UF_6, but its lower reactivity requires much higher reaction temperatures (450°C). Cold technology problems on chemical decladding of stainless steel canned UO_2 fuel using HF + O are briefly mentioned. Results from the volatilization of UF_6 in fluidized packed-bed reactors are listed. The reaction rates and efficiencies in large columns of various fluorinating gases (ClF_3, ClF, F_2, HF + O_2) are discussed and compared. UF_6 volatilization rates with ClF_3 on UO_2-PuO_2 pellets, are discussed along with simultaneous removal of Pu either by volatilization of PuF_6 with F_2 or by elutriation of Pu containing fines. Conceptual design work was devoted essentially to the study of mechanical decanning. (auth) (EURATOM)

9429 (IN–1314) CHEMICAL TECHNOLOGY BRANCH ANNUAL REPORT, FISCAL YEAR 1969. Bower, J. R. (ed.) (Idaho Nuclear Corp., Idaho Falls). Oct 1969. Contract AT(10-1)-1230. 103p. Dep. CFSTI.

Research progress is reported on performance of ICPP fuel recovery processes, fluidized-bed denitration of ICPP product, graphite fuels reprocessing, electrolytic dissolution process for EBR-II fuel, zirconium oxide fuel process, operating experience in the Idaho Waste Calcining Facility, storage of solid waste, calcination using in-bed combustion of fuel for heating, waste management studies, LOFT assistance program, and other reactor technology support programs. (M.C.G.)

9430 (IN–1329) URANIUM RECOVERY FROM ALUMINUM ALLOYED FUEL ICPP RUN NO. 25. Bendixsen, C. L.; Matule, A. J. (Idaho Nuclear Corp., Idaho Falls). Oct 1969. Contract AT(10-1)-1230. 33p. Dep. CFSTI.

About 677 kg of highly enriched uranium were recovered from aluminum alloyed fuels during Run No. 25 at the Idaho Chemical Processing Plant. Overall product recovery was greater than 99.93 percent and all product easily met required specifications. The feasibility of recovering neptunium at ICPP was again demonstrated by recovering 99% of the neptunium in the second-cycle raffinate generated during the campaign. Pre-run modifications to the extraction systems simplified the processing campaign; and as a result of the experience gained on the run, other modifications are actively being considered at the ICPP. (auth)

9431 (JPRS–49539) PROSPECTS FOR TREATING WATER FROM NUCLEAR ELECTRIC POWER STATIONS WITH PULVERIZED IONITES. Martynova, O. I.; Subbotina, N. P.; Kopylov, A. S. Translated from At. Energ. (USSR); 27: 91-5(1969). 8p. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 23: 40838.

9432 (KFK–904) DETERMINATION OF IN-PROCESS INVENTORY IN A REPROCESSING PLANT BY MEANS OF ISOTOPE ANALYSIS. Winter, H.; Avenhaus, R.; Gupta, D.; Katz, F.; Kraemer, R. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Reaktorphysik). Jul 1969. 66p. Dep. CFSTI (U. S. Sales Only).

A method of independent determination of in-process inventory in a reprocessing plant is discussed. The method is based on measurement of different fissile isotope concentrations in the input and output batches of a reprocessing plant. Topics covered include: principle of process inventory determination by isotope analyses, analysis of a typical reprocessing plant, simulation of a reprocessing plant in an analog computer, statistical statements about a diversion in the case of inventory determinations by tracer methods, and differences in isotopic composition of fuel from one reactor. (M.C.G.)

9433 (LIB-Trans–224) D_2O SUPPLY BY THE HYDROGEN–AMMONIA TWO-TEMPERATURE PROCESS. Becker, E. W.; Lange, G.; Schindewolfe, U. Translated by Peter J. F. Newton (Australian Atomic Energy Commission Research Establishment, Lucas Heights), from Atomwirt., Atomtech.; 14: 257-60(1969). 14p. Dep. CFSTI (U. S. Sales Only).

An abstract of this paper, prepared from the original language, appeared as NSA 23: 26347.

9434 (NYO–4057-1) SEPARATION OF KRYPTON AND XENON FROM REACTOR ATMOSPHERES BY SELECTIVE PERMEATION. Progress Report, January 1–December 31, 1969. Stern, S. A. (Syracuse Univ., N. Y. Dept. of Chemical Engineering and Metallurgy). Contract AT(30-1)-4057. 33p. Dep. CFSTI.

Studies are being made to develop an efficient process for removing rare gas fission products from nuclear reactor atmospheres by selective permeation through nonporous polymeric membranes. The potential value of anisotropic (cellulose acetate) membranes for the removal of Kr and Xe fission products is being investigated. (M.C.G.)

9435 (ORNL-TM–2412(Pt.4)) DESIGN CONSIDERATIONS OF REACTOR CONTAINMENT SPRAY SYSTEMS. PART IV. CALCULATION OF IODINE-WATER PARTITION COEFFICIENTS. Parsly, L. F. (Oak Ridge National Lab., Tenn.). Jan 1970. Contract W-7405-eng-26. 56p. Dep. CFSTI.

Procedures for calculating the partition coefficient of iodine between water and air from solubility, vapor pressure, and hydrolysis equilibrium data are described. Results are presented in tabular form covering the pH range 5.0 to 9.5, the temperature range 25 to 150°C, and dissolved iodine concentrations ranging from saturated solutions down to 10^{-9} mole/liter. (auth)

9436 (ORNL-TM–2792) THORIUM FUEL CYCLE DEVELOPMENT PROGRESS REPORT NO. 5, DECEMBER 1969. (Oak Ridge National Lab., Tenn.). Jan 1970. Contract W-7405-eng-26. 16p. Dep. CFSTI.

Research and development are reported on head-end reprocessing, refabrication, materials irradiation, and ^{233}U reprocessing. (M.C.G.)

9437 (ORNL-TM–2846) THORIUM FUEL CYCLE DEVELOPMENT PROGRESS REPORT NO. 6, JANUARY 1970. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. 20p. Dep. CFSTI.

Research and development are reported on head-end reprocessing, refabrication, materials irradiation, and ^{233}U reprocessing. (M.C.G.)

9438 (ORNL-tr–1881) PROCEDURE FOR PRELIMINARY DECONTAMINATION OF NUCLEAR FUELS TO BE PROCESSED. Baihr, Werner; Vogg, Hubert. Translated by R. Gregg Mansfield (Oak Ridge National Lab., Tenn.), from German Patent 1,184,503. 4p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 19: 20084.

9439 (RFP–1416) PREPARATION OF HIGHLY PURE NEPTUNIUM OXIDE. Conner, William V.; Procter, Stephen G.

(Dow Chemical Co., Golden, Colo. Rocky Flats Div.). 23 Dec 1969. Contract AT(29-1)-1106. 5p. Dep. CFSTI.

A 200-gram batch of neptunium was purified using a combined nitrate and chloride anion exchange process. The actinide impurity content of the purified NpO_2 product was <0.1 ppM of plutonium and americium, <0.2 ppM thorium, and 7 ppM uranium. The total for all impurities was 407 ppM. (auth)

9440 ON THE POSSIBILITY OF USING SYNTHETIC ZEOLITES FOR SEPARATION OF LITHIUM ISOTOPES. Chumakov, V. A.; Gorshkov, V. L.; Tolmachev, A. M.; Fedorov, V. A. Vestn. Mosk. Univ., Ser. II. Khim.; No. 5, 22-4(Sep-Oct 1969). (In Russian).

The single stage separation factors for lithium isotope exchange between ions in aqueous solution and zeolites of A- and X-types, mordenite and analzite, were determined. The values are 1.016, 1.019, 1.017, 1.024 and are independent on the concentration of the solution. Countercurrent columns were used for concentrating ^6Li isotope upon lithium ion displacement from zeolite X by ammonium ions, the enrichment factor being 1.35. In all cases lithium ion displacement was incomplete. (auth)

9441 OXYGEN ISOTOPE FRACTIONATION IN DIVALENT METAL CARBONATES. O'Neil, James R.; Clayton, Robert N.; Mayeda, Toshiko K. (Univ. of Chicago). J. Chem. Phys.; 51: 5547-58(1 Dec 1969).

Equilibrium fractionation factors for the distribution of ^{18}O between alkaline-earth carbonates and water were measured over the temperature range 0 to 500°C. The fractionation factors α can be represented by the equations $CaCO_3-H_2O$, $1000 \ln\alpha = 2.78 (10^6 T^{-2})-3.39$, $SrCO_3-H_2O$, $1000 \ln\alpha = 2.69 (10^6 T^{-2})-3.74$, $BaCO_3-H_2O$, $1000 \ln\alpha = 2.57 (10^6 T^{-2})-4.73$. Measurements on $MnCO_3$, $CdCO_3$, and $PbCO_3$ were made at isolated temperatures. A statistical-mechanical calculation of the isotopic partition function ratios gives reasonably good agreement with experiment. Both cationic size and mass are important in isotopic fractionation, the former predominantly in its effect on the internal vibrations of the anion, the latter in its effect on the lattice vibrations. (auth)

9442 ION-EXCHANGE ADSORPTION OF RADIONUCLIDES BY FERROCYANIDE MOLYBDATE. Kawamura, Shoichi; Kurotaki, Katsumi (National Inst. of Radiological Sciences, Chiba, Japan). J. Chromatogr.; 45: 331-5(9 Dec 1969).

Three varieties of ferrocyanide molybdate (FeMo) were prepared by varying the mixing ratio of the starting materials. One of them (No. 3) was found to be hardly soluble in water, permitting adsorption of radionuclides in aqueous media. Results are reported for studies on: comparison of the solubility or adsorption behavior of three adsorbents; relation between the distribution coefficient of No. 3 and HNO_3 concentrations; variation of adsorption behavior of No. 3 with or without addition of concentrated salts; adsorption behavior of several radionuclides for No. 3 in seawater; and isolation of ^{137}Cs from seawater containing ^{85}Sr, ^{144}Ce, ^{137}Cs, etc. through the column studies. It was found that the K_d values for the radionuclides in seawater are nearly coincident with those in 0.5 M NaCl. (P.C.H.)

9443 THE USE OF HIGH-EFFICIENCY PACKED COLUMNS FOR GAS-SOLID CHROMATOGRAPHY. I. THE COMPLETE SEPARATION OF $^{14}N_2-^{15}N_2$. Bruner, F.; Di Corcia, A. (Univ., Rome). J. Chromatogr.; 45: 304-5(9 Dec 1969).

The equipment and method are described for the chromatographic separation of $^{14}N_2-^{15}N_2$. A Carlo Erba Model AtC/f gas chromatograph equipped with a thermal conductivity cell was used. The apparatus was modified for low-temperature work by connecting the cell to the column, fitted in a large dewar container with two narrow copper tubings of negligible volume. The chromatogram obtained is illustrated. The sample injected was 0.2 cc. Resolution was 1.2 and the ratio of corrected retention volumes was 1.03, which showed that under the conditions used an unusually large isotope effect took place. (P.C.H.)

9444 ISOTOPE EXCHANGE BETWEEN A DEUTERATED GAS AND AMMONIA. Roth, Etienne; Lefrancois, Bernard (to Houilleres du Bassin du Nord and du Pas-de-Calais). U. S. Patent 3,479,140. 18 Nov 1969. Priority date 27 Jul 1966, France.

A bithermal process is described for isotope exchange between a deuterated gas and ammonia. The isotope exchange takes place in two towers between which there is an inlet for the feed gases that pass between an ammonia cracking reactor and an ammonia synthesis reactor. The pressure in at least one isotope exchange tower is maintained equal to or slightly lower than the pressure of the gases leaving the ammonia cracking reactor. (Offic. Gaz.)

9445 SOLVENT EXTRACTION IN THE ATOMIC ENERGY INDUSTRY. Healy, T. V.; Jenkins, I. L.; McKay, H. A. C. (Atomic Energy Research Establishment, Harwell, Eng.). Rep. Progr. Appl. Chem.; 53: 681-96(1968).

A general picture of the current situation is presented. Applications to radioisotopes other than fission products are not included. Headings are as follows: Uranium recovery; use of amines; use of organophosphorus compounds; thorium recovery; processing of irradiated nuclear fuel and thorium (reprocessing of natural and low enrichment uranium fuels; reprocessing of highly enriched uranium; recovery of neptunium; processes for irradiated thorium; some reprocessing problems); production of the rarer actinides (^{231}Pa, ^{239}Pu, higher products); recovery of fission product and other elements (Oak Ridge group process; SREX process; Russian scheme for group separation; other fission product separations). 107 references. (UK)

9446 ION FRACTIONATION BY FOAM. Jorne, Jacob (Univ. of California, Berkeley); Rubin, Eliezer. Separ. Sci.; 4: 313-24(Aug 1969).

Ionic charge and size of the species present govern the selectivity of surface adsorption of counterions in foam fractionation processes. A theory based on the Gouy–Chapman model of the diffuse double layer, with the restriction that the closest approach to the surface is determined by the finite size of the hydrated ions, enables the distribution factor of each species between a solution of mixed electrolytes and a surface layer to be predicted, and the selective adsorption coefficient between two ions to be calculated. Good agreement was found between the theoretical prediction and experimental data. (auth)

9447 SOLVENT EXTRACTION SEPARATION OF MANGANESE(II) WITH TRIBUTYL PHOSPHATE. Yadav, A. A.; Khopkar, S. M. (Indian Inst. of Tech., Bombay). Separ. Sci.; 4: 349-55(Aug 1969).

A fast and selective method is proposed for solvent extraction of manganese with tributyl phosphate. It is possible to quantitatively extract manganese with 40% tributyl phosphate in xylene from solutions containing 1 M hydrochloric acid and 2.5 M aluminum chloride as the salting-out agent. The metal from the organic phase is stripped with water and is determined photometrically as its complex with formaldoxime. The probable composition of the extractable species at 1 M acidity is [$MnCl_2 \cdot$ 3TBP]. It is possible to extract manganese in the presence of a twentyfold excess of common ions, but mercury, copper, iron, bismuth, and vanadium interfere. The standard deviation is ±1.05%. (auth)

9448 ISOTOPE FRACTIONATIONS OF DEUTERIUM IN NATURE. Ponticorvo, Laura. New York, N. Y.; Columbia Univ. (1968). 94p.

Thesis.

A selected survey was conducted on the natural abundance of D in organic compounds of biological origin obtained from commercial sources or isolated from living systems. Some of the compounds, obtained from commercial sources, glucose and corn starch, were enriched in D while others, stearic acid, linolenic acid, and cholesterol, were deficient in D compared to New York City tap water. However, it was difficult to interpret these results because the D concentration of the medium in which they had been synthesized was unknown. The deuterium abundances of compounds isolated from living systems are more meaningful in that they can be related to the water in which they are synthesized. The results clearly indicated that fractionation of the hydrogens was occurring in biological systems. Other possible sources of fractionation are discussed. In order to gain further insight on the fractionation processes at the molecular level, the reactions of glucose fermentation in three different organisms were investigated; the conversion of glucose 1) to ethanol by yeast, 2) to lactic acid by L. casei and 3) to both ethanol and lactic acid by the heterofermentative organism, L. mesenteroides. The end products of fermentation had a lower D concentration than the starting glucose. The acetate derived from the chemical oxidation of these products proved to be even lower in D content. This demonstrated that the methyl group of ethanol and that of lactic acid had very low D concentrations. Ethanol formation in yeast and lactic acid formation in the two other bacterial systems stem from pyruvic acid as a common intermediate. The conversion of phosphoenol pyruvic acid to pyruvic acid, involving the introduction of a proton from the solvent, could give rise to the low D concentrations found in the methyl groups of ethanol and lactic acid. The D abundance for this proton, calculated from the available data, was found to have a D concentration far below that of the water medium. This finding was corroborated by measuring the rate and product isotope effects for this reaction in $H_2O + D_2O$ mixtures. In all three systems studied, the reactions

where a proton was introduced into a molecule from the aqueous medium irreversibly, were characterized by large fractionation factors. This appears to be a general reaction that accounts for the low D concentrations found in all the biological compounds that were analyzed. (Diss. Abstr.)

9449 RECENT ADVANCES IN REPROCESSING OF IRRADIATED FUEL. NUCLEAR ENGINEERING. PART XX. 60th Annual Meeting of the American Institute of Chemical Engineers Held in New York, November 30, 1967. Rodger, W. A.; Ferguson, D. E. (eds.). Chem. Eng. Progr.; 65: Symp. Ser. No. 94, 1-111(1969). (CONF-671103).

Eleven papers on recent advances in methods for reprocessing irradiated fuels are presented. An abstract was prepared for each. (L.C.L.)

For abstracts of individual papers see: 9450–9453, 9563–9567, 9627, and 9628.

9450 AQUEOUS REPROCESSING IN A MULTIPURPOSE PLANT. Barendregt, T. J.; Detilleux, E.; Rometsch, R. (EUROCHEMIC, Mol, Belg.). Chem. Eng. Progr.; 65: Symp. Ser. No. 94, 1-19(1969).

From 60th Annual Meeting of the American Institute of Chemical Engineers, New York. See CONF-671103.

The Eurochemic reprocessing plant has now been in operation for more than one year. In this period, some 35 tons of irradiated fuel originating from seven reactors with different canning material, fuel, size, shape, enrichment, and burnup have been successfully treated. The different head-end methods used, the separation process, and the measures taken to cope with the various enrichments both for criticality and accountability reasons are described. The behavior of the equipment and instruments and the problems which arose in this first year are discussed. Special emphasis is given to the safety aspects in view of the location of the plant in a densely populated area. A preliminary cost analysis is presented. (auth)

9451 OPERATING EXPERIENCE WITH THE FUEL REPROCESSING PLANT AT TROMBAY. Sethna, H. N.; Srinivasan, S. N. (Bhabha Atomic Research Centre, Trombay, India). Chem. Eng. Progr.; 65: Symp. Ser. No. 94, 20-5(1969).

From 60th Annual Meeting of the American Institute of Chemical Engineers, New York. See CONF-671103.

The fuel reprocessing plant at Trombay has been in operation for 3 yr. A brief description of the plant and the processes followed and the operating experience in processing the irradiated fuel from a 40 MW research reactor during this period are presented. Information regarding process conditions, product specifications, equipment performance, decontamination procedures, sampling, and analytical methods is furnished. The problems associated with personnel training and the proposals for automation of the operations are mentioned. Data are included regarding personnel radiation exposure and contamination. Experience with handling plutonium compounds for conversion to metal is also discussed. The administrative machinery for ensuring safe and efficient operation of the plant is outlined. (auth)

9452 RECENT DEVELOPMENTS IN THE INDUSTRIAL REPROCESSING OF IRRADIATED FUELS IN FRANCE. Couture, Jacques (CEN, Chatillon-Sous-Bagneux, France). Chem. Eng. Progr.; 65: Symp. Ser. No. 94, 26-32(1969).

From 60th Annual Meeting of the American Institute of Chemical Engineers, New York. See CONF-671103.

The irradiated fuel reprocessing plants are now functioning in France. One of these is located at Marcoule in Southeastern France and was commissioned in 1958. The other plant is situated at La Hague, near Cherbourg in the Northwestern region, and has been running since 1966. The installations for mechanical decanning, continuous dissolution, mixer-settler extraction, and fission product concentration are very similar in both plants. On the other hand, the processes and technology used in plutonium purification are utterly different. In the field of effluent reprocessing, a plant for the coating of sludge with bitumen has already been operating smoothly for 2 yr. at Marcoule. As regards development, we are planning to start in 1968 the following plants: at La Hague, a fuel processing installation for the Rapsodie breeder; at Marcoule, a commercial sized pilot plant for fission product vitrification. Other investigations, particularly the dry reprocessing of fuel, are being carried out at the Centre de Fontenay-aux Roses. (auth)

9453 APPLICATIONS OF SOLUBLE NEUTRON POISONS IN AQUEOUS FUEL REPROCESSING. Morrison, W. G.; Buckham, J. A. (Idaho Nuclear Corp., Idaho Falls). Chem. Eng. Progr.; 65: Symp. Ser. No. 94, 78-88(1969).

From 60th Annual Meeting of the American Institute of Chemical Engineers, New York. See CONF-671103.

Use of solute poison for primary nuclear criticality safety control has been successfully employed with zirconium fuels at the Idaho Chemical Processing Plant. Extension of this concept to various other fuels is discussed. The effects of fuel composition, dissolver geometry, and system chemistry on safe design and operation are covered. (auth)

9454 SOME O,O,S-TRIALKYL DITHIOPHOSPHATES AS EXTRACTANTS FOR MOLYBDENUM. Busev, A. I.; Rodionova, T. V. Vestn. Mosk. Univ., Ser. II. Khim.; No. 5, 77-9(Sep-Oct 1969). (In Russian).

The extraction of molybdenum with some O,O,S-trialkyl dithiophosphates was studied. O,O,S-triethyl dithiophosphate was found to be the best extractant. (auth)

9455 EXTRACTION OF URANIUM FROM SOLUTIONS OF TRICHLOROACETIC AND ACETIC ACIDS BY BINARY MIXTURES OF ALKYL PHOSPHATES. Vykhovtsov, V. L.; Melikhova, G. N. Radiokhimiya; 11: 480-1(1969). (In Russian).

The extraction of uranium from acetic and trichloroacetic acid solutions by equimolar mixtures of bis(2-ethylhexyl) phosphate–tributyl phosphate and diheptylphosphinic acid–tributyl phosphate at 25°C and a contact time of 3 min was studied. Synergistic effects were observed. (M.C.G.)

9456 EXTRACTION OF SCANDIUM BY TRIBUTYL PHOSPHATE FROM PERCHLORIC ACID SOLUTIONS. Samodelov, A. P. Radiokhimiya; 11: 447-50(1969). (In Russian).

The distribution of scandium between aqueous perchloric acid solutions and tributyl phosphate was studied. It was established that scandium is extracted in the form of the solvate, $Sc(ClO_4)_3 \cdot 3TBP$, in the region of high concentration of scandium perchlorate and in the form of the solvate, $Sc(ClO_4)_3 \cdot 3TBP \cdot HClO_4 \times TBP \cdot nH_2O$, at low concentrations of scandium perchlorate. (tr-auth)

9457 THERMOCHEMISTRY OF THE EXTRACTION OF LANTHANIDE NITRATES BY TRIBUTYL PHOSPHATE (TBP). Afanas'ev, Yu. A.; Babina, K. A. Radiokhimiya; 11: 443-5 (1969). (In Russian).

Studies of the thermodynamics of extraction of rare earths from nitrate solutions by TBP showed that one of the causes of change of entropy in the series of lanthanides can be a change in the structural order of the organic phase. (M.C.G.)

9458 PRECIPITATION IN SPECIFIC MEDIA: A METHOD FOR THE SEPARATION OF CHEMICALLY CLOSELY RELATED ELEMENTS AND PREPARATION OF DEFINED COMPOUNDS. Pajakoff, Sw. (Institut fuer Verfahrenstechnik, Vienna. Technische Hochschule, Vienna). Monatsh. Chem.; 100: 1350-61 (Jul-Aug 1969). (In German).

Precipitation in specific media and under controlled conditions, i.e., slow crystal growth at optimum pH-value, constant molar ratio and constant temperature maintained during the whole precipitation process, was found to be a valuable tool for the separation of the closely related rare earth elements, platinum elements, niobium and tantalum, as well as for the preparation of well-defined compounds of the rare earth metals with molybdenum, vanadium, and boron. (auth)

9459 EXTRACTION OF TETRAVALENT THORIUM WITH SOLVENT MIXTURES: 2-THENOYLTRIFLUOROACETONE AND TRIBUTYL PHOSPHATE. Genov, L.; Kassabov, G. (Chemisch-Technologische Instituts, Sofia). Monatsh. Chem.; 100: 594-601(Mar-Apr 1969). (In German).

The distribution of Th^{4+} between diluted aqueous nitric acid of ion strength 1 m and a benzene phase containing 2-thenoyltrifluoroacetone (HTTA) and tributylphosphate (TBP) of an overall concentration not exceeding 0.1 m was studied. Thorium was found to be extracted as a complex having the composition $Th(TTA)_3NO_3TBP$ and a formation constant 3.7×10^3. (auth)

9460 EXTRACTION OF LANTHANIDES BY MEANS OF A MIXTURE OF TRI-n-BUTYL PHOSPHATE AND DI-n-BUTYL BUTYLPHOSPHONATE. Genov, L.; Georgiev, G. (Chemisch-Technologische Instituts, Sofia). Monatsh. Chem.; 100: 1240-5 (Jul-Aug 1969). (In German).

The extraction of praseodymium and ytterbium with mixtures of tributyl phosphate and dibutyl butylphosphonate dissolved in CCl_4, C_6H_6, and ethyl isobutyl ketone was investigated. The experimental results lead to the conclusion that besides simple complexes as for instance $Me(NO_3)_3 \cdot 3\,S_1$ and $Me(NO_3)_3 \cdot 3\,S_2$ mixed complexes of the type $Me(NO_3)_3 \cdot 2\,S_1 \cdot S_2$ and $Me(NO_3)_3 \cdot S_1 \cdot 2\,S_2$ are also formed and consequently lead to an increase of the distribution coefficients. In this case, the relationships $K_{12} = 3\sqrt{K_{30}K_{03}^2}$ and $K_{21} = 3\sqrt{K_{30}^2K_{03}}$

will be valid for the extraction. It is assumed that these relationships will change with the use of other solvents for extraction. (auth)

9461 REPROCESSING OF IRRADIATED FUELS BY THE WET METHOD: TECHNICAL IMPROVEMENTS PROPOSED. Mamelle, J. (Saint-Gobain Techniques Nouvelles, Courbevoie, France); Regnaut, P. pp 339-60 of Economics of Nuclear Fuels. Vienna; International Atomic Energy Agency (1968). (In French).

From Symposium on Economics of Nuclear Fuels, Gottwaldov, Czechoslovakia. See STI/PUB-188; CONF-680541.

The wet method derived from the Purex chain is now the only fuel reprocessing method operated on an industrial scale. This process is used for metallic natural uranium, slightly enriched uranium oxide and highly enriched uranium; but it can also be applied to the fuels of future breeders. The effect of reprocessing costs on the price of electricity per kWh varies greatly from one type of reactor to another. However, in all cases a tendency for aggregation of reprocessing costs is found, i.e., the sum of operating costs and amortization charges, comes down. Moreover, efforts are being made to increase safety and to simplify such problems as effluent disposal, biological protection and criticality control. These aims must be achieved, however, at a time when the capacities of industrial reprocessing plants are steadily increasing, and when, as a result of higher burn-ups, the concentrations of fissile material and the activities that must be handled are also rising. It is therefore essential to continue the search for technical improvements. The proposed research bears particularly on continuous operation and greater automation, for example by on-line controls. These tendencies can be noted in fields such as continuous leaching of clad uranium oxide elements after chopping; solvent extraction in centrifugal extractors; plutonium purification by tributyl phosphate extraction with refluxing, or with trilaurylamine; and continuous precipitation and filtration of plutonium oxalate. Some of these improvements are described, their characteristics discussed, and an examination is made of their repercussions on the investment and operating costs of an industrial reprocessing plant. The operator stands to gain by extracting some of the by-products and turning them to practical account. For example, the fission products (cesium, strontium, rare-earth elements) and transuranium elements (neptunium, americium) can be of value. A process for the recovery of neptunium with trilaurylamine has been tested and appears promising. (auth)

9462 STUDIES ON REPROCESSING OF IRRADIATED FUELS BY THE DRY METHOD INCLUDING THE ECONOMIC ASPECTS. Cochet-Muchy, B. (Societe Ugine Kuhlmann, Lyon); Sauteron, J. pp 361-80 of Economics of Nuclear Fuels. Vienna; International Atomic Energy Agency (1968). (In French).

From Symposium on Economics of Nuclear Fuels, Gottwaldov, Czechoslovakia. See STI/PUB-188; CONF-680541.

The fundamentals of the dry method of reprocessing irradiated fuels are summarized. In particular, consideration is given to the economic aspects of reprocessing by volatilization of irradiated fuels from fast breeders, assuming a daily throughput of 40 kg of fuel (U + Pu), corresponding to a 1000 MW(e) fast reactor. The process consists of chemical removal of cladding with a mixture of hydrofluoric acid and oxygen; simultaneous volatilization of uranium and plutonium by fluorine; uranium–plutonium separation and production of PuO_2; and purification of UF_6 and production of UO_2. Basic layout, materials balance and workshop design are described. An estimate is also given of plant construction costs and an indication of what the various operating costs might be. (auth)

9463 EFFECT OF COOLING TIME OF IRRADIATED FUELS ON DIFFERENT ASPECTS OF FAST-BREEDER FUEL REPROCESSING COSTS. Gupta, D. (Kernforschungszentrum, Karlsruhe, Ger.); Zuehlke, P. pp 557-69 of Economics of Nuclear Fuels. Vienna; International Atomic Energy Agency (1968).

From Symposium on Economics of Nuclear Fuels, Gottwaldov, Czechoslovakia. See STI/PUB-188; CONF-680541.

As a result of investigating a suitable method of reprocessing plutonium fast-breeder fuels it has become obvious that the conventional aqueous reprocessing based on the Purex-process for irradiated fuels from converter type reactors can be conveniently adapted for this purpose. The changes, which are mainly confined to the head-end part and the end purification of plutonium, cause some increase in the base reprocessing costs. These costs, however, may be sensitive to the number of days the irradiated fuel has been cooled before reprocessing. The interest charges on the bound plutonium decrease with decreasing cooling time but the plant and operation costs in several parts of a reprocessing plant tend to increase because of higher activity and higher decay heat of the short cooled fuels. Assessment of these factors leads to the opinion that the expected cost increases in an aqueous reprocessing plant may not exceed the savings in interest charges in the post-irradiation cooling time ranges of 50 to 200 days. (auth)

9464 EXTRACTION OF RUTHENIUM TETROXIDE FROM IRRADIATED URANIUM FUEL SAMPLES. Smulek, W. (Inst. of Nuclear Research, Warsaw). Radiochem. Radioanal. Lett.; 2: 265-71(27 Dec 1969).

A procedure for the separation of ruthenium from irradiated UO_2–Mg fuel samples was developed. The oxidant applied was potassium periodate, and ruthenium tetroxide was extracted by mepasine. It was found that in one extraction operation more than 98% of the ruthenium in the fuel passed into the organic phase. Various factors influencing the extent of extraction were examined. (auth)

9465 IRRADIATED FUEL SERVICES AND THE REACTOR OPERATOR. Williams, J. A.; Kavanagh, M. J. Risley, Eng.; United Kingdom Atomic Energy Authority (1969). 29p.

The main factors involved in maximising the value of irradiated fuel are discussed under the following headings: Value of irradiated fuel; summary of main factors; fuel handling at reactor site; flask design; transport route; safety requirements; insurance; selection of reprocessing plant; re-use of recovered uranium; use of plutonium; overall timescale and economies. (UK)

9466 BEHAVIOR IN THE EXTRACTION OF THE RARE ELEMENTS AND NITRIC ACID IN SYSTEMS $Ln(NO_3)_3$–HNO_3–H_2O–TBP. Nikolaev, A. W.; Ryabinin, A. I. Inst. of Inorganic Chemistry, Novosibirsk, USSR). Izv. Sib. Otd. Akad. Nauk SSSR; No. 12, Ser. Khim. Nauk, No. 5, 33-8(Sep 1969). (In Russian).

Six quaternary extraction and solubility systems of the type $Ln(NO_3)_3$–HNO_3–H_2O–TBP (Ln is La, Pr, Sm, Gd, Ho, Lu), were investigated at 25°. Distribution coefficients were calculated. (auth)

9467 EXTRACTION IN THE SYSTEM $Nd(NO_3)_3$–HNO_3–H_2O–$(C_4H_9O)_3PO$ AT 25°C. Nikolaev, A. V.; Mironov, K. E.; Karaseva, E. V.; Ryabinin, A. I. (Inst. of Inorganic Chemistry, Novosibirsk, USSR). Izv. Sib. Otd. Akad. Nauk SSSR; No. 12, Ser. Khim. Nauk, No. 5, 38-42(Sep 1969). (In Russian).

The extraction of neodymium and nitric acid with tributyl phosphate in the above system at 25°C was studied. Distribution coefficients for neodymium, praseodymium or samarium as well as the extraction of HNO_3 in the corresponding system are compared. Extraction was compared for neodymium, praseodymium, and samarium nitrates from aqueous solvents without acid. (auth)

9468 KINETICS OF EXTRACTION OF METALS WITH ORGANOPHOSPHORUS COMPOUNDS. Baumgaertner, F.; Finsterwalder, L. (Univ., Heidelberg). pp 652-4 of Progress in Coordination Chemistry. /Cais, Michael (ed.). New York; American Elsevier Publishing Company, Inc. (1968).

From 11th International Conference on Coordination Chemistry, Haifa and Jerusalem, Israel. See CONF-680912-(Absts.).

Studies of U(VI) and Pu(IV) mass transfer across the H_2O–HNO_3/TBP–dodecane interface showed an interfacial complex participating in a rate-determining step of the transfer reaction. (M.C.G.)

9469 SYNERGISTIC ADDUCTS AS CO-ORDINATION COMPOUNDS. Healy, T. V. (Atomic Energy Research Establishment, Harwell, Eng.). pp 659-61 of Progress in Coordination Chemistry. /Cais, Michael (ed.). New York; American Elsevier Publishing Company, Inc. (1968).

From 11th International Conference on Coordination Chemistry, Haifa and Jerusalem, Israel. See CONF-680912-(Absts.).

Synergism in solvent extraction, especially for U, Pu, lanthanides, other actinides, Th, and Cu, is discussed. The conditions under which a metal chelate is stable and whether a synergistic adduct will form a more stable complex were investigated. (M.C.G.)

9470 GAS CHROMATOGRAPHIC AND PARTITION STUDIES OF THE SYSTEM: TBP–HNO_3–H_2O DILUENT. Apelblat, Alexander (Israel Atomic Energy Commission, Negev, Israel). pp 662-4 of Progress in Coordination Chemistry. /Cais, Michael (ed.). New York; American Elsevier Publishing Company, Inc. (1968).

From 11th International Conference on Coordination Chemistry, Haifa and Jerusalem, Israel. See CONF-680912-(Absts.).

Results of studies of HNO_3 and H_2O partition between the aqueous phase and TBP diluted by benzene, CCl_4, or $CHCl_3$, as well as undiluted TBP, at 25, 35, and 45°C are reported. In order to obtain further information about the diluent effect, the gas chromatographic behavior of benzene, CCl_4, $CHCl_3$, hexane, cyclohexane, acetone, and methanol was studied on TBP + HNO_3 columns. A

plot of the specific retention volume of the diluent as a function of the HNO_3 concentration in the organic phase showed the existence of a number of maxima and minima, and the appearance of peaks on the curve was significant at some temperatures, but decreased gradually with increasing temperature. The peak position was independent of temperature. (B.L.M.)

9471 EXTRACTION OF Pu(IV) BY MIXTURES OF TBP AND TLA FROM NITRIC ACID SOLUTIONS. Bac, R. (Institutt for Atomenergi, Kjeller, Norway). pp 668-70 of Progress in Coordination Chemistry. /Cais, Michael (ed.). New York; American Elsevier Publishing Company, Inc. (1968).

Studies of the extraction of Pu(IV) using mixtures of TBP and tridodecylamine from HNO_3 were carried out to determine the influence of aqueous HNO_3 concentration, of concentration ratios of TBP to tridodecylamine, and of uranium saturation of the TBP extracting agent. The results for the determination of the distribution coefficient of Pu(IV) under various conditions are tabulated. Using this extraction information, a 16-stage mini mixer-settler was developed and tested for the recovery of Pu from a HNO_3 solution containing 150 g U/l, 15 to 20 g Pu/l, 3M HNO_3, and fission products. The decontamination factors for the various fission products are tabulated. (B.L.M.)

9472 EMPIRICAL FUNCTIONS FOR THE CALCULATION OF SIMULTANEOUS DISTRIBUTION OF PU(IV) AND U(VI) IN THE SYSTEM METAL NITRATE-NITRIC ACID-TRIBUTYL PHOSPHATE-N-DODECANE. Ochsenfeld, W.; Baumgaertel, G.; Schmieder, H. (Kernforschungszentrum, Karlsruhe, Ger.). pp 671-2 of Progress in Coordination Chemistry. /Cais, Michael (ed.). New York; American Elsevier Publishing Company, Inc. (1968).

From 11th International Conference on Coordination Chemistry, Haifa and Jerusalem, Israel. See CONF-680912-(Absts.).

The simultaneous distribution of Pu and U was determined over a wide range of concentrations in the system $Pu(NO_3)_3$–$UO_2(NO_3)_2$–TBP–dodecane. From these data, empirical functions were derived that allow the calculation of distribution coefficients under other conditions. The equations are presented. (B.L.M.)

9473 EXTRACTION STUDIES OF CERIUM(III) INTO DI-(2-ETHYLHEXYL)PHOSPHORIC ACID AND THE OBSERVATION OF ITS OXIDATION IN THE PRESENCE OF CONCENTRATED NITRATE SOLUTIONS TO FORM A CE(IV)–NITRATE–DEHP COMPLEX. Bray, L. A.; Partridge, J. A. (Battelle-Northwest, Richland, Wash.). pp 673-4 of Progress in Coordination Chemistry. /Cais, Michael (ed.). New York; American Elsevier Publishing Company, Inc. (1968).

From 11th International Conference on Coordination Chemistry, Haifa and Jerusalem, Israel. See CONF-680912-(Absts.).

The Ce(III) and Ce(IV) salts of bis(2-ethylhexyl) phosphate were prepared and investigated. The Ce(III) salt was prepared by contacting DEHPA–toluene with a saturated aqueous solution of $Ce_2(SO_4)_3$ or by contacting the organic phase with water containing $Ce(OH)_3$. The Ce(IV) salt was prepared by contacting a DEHPA–toluene solution with a saturated solution of $Ce(NO_3)_3$. Elemental analysis showed the Ce(III)–DEHPA to have a DEHPA to Ce ratio of 3 and the Ce(IV) salt to have a ratio of 2. The ir spectra of the two salts were determined. Both salts are highly polymerized in solution. Vapor pressure osmometer data indicated a degree of polymerization of 16 ± 1 for the Ce(III) salt in cyclohexane and of 18 ± 3 for the Ce(IV) salt. (B.L.M.)

9474 FORMATION OF COMPLEXES IN SYSTEMS INVOLVING ACIDIC ORGANOPHOSPHORUS EXTRACTANTS. Kolarik, Zdenek; Sistkova, Nina V.; Hejna, Jaroslava (Inst. of Nuclear Research, Rez, Czech.). pp 678-80 of Progress in Coordination Chemistry. /Cais, Michael (ed.). New York; American Elsevier Publishing Company, Inc. (1968).

From 11th International Conference on Coordination Chemistry, Haifa and Jerusalem, Israel. See CONF-680912-(Absts.).

The influence of the alkyl chain length in the molecule of the extractant on its complex-forming properties was investigated for the distribution of Ce(III), Eu(III), Sr(II), and Ca(II) between aqueous 1M ($NaNO_3$ + HNO_3) and organic solutions of dibutyl (HDBP), diamyl (HDAP), dihexyl (HDH_xP), and dioctyl (HDOP) phosphates. The self-association constants and partition coefficients of these acids were determined by distribution measurements. The complex of the type $MA_3 \cdot xHA$ where x = 3 was most often found in the organic phase for Ce(III), but complexes with x = 1 and 2 were also found. For Ca(II) and Sr(II) x = 2, 3, or 4. The value of x was also found to vary with the alkyl chain length in the HA molecule in some solvents. The complex formation of Ce(III) and Tb(III) with HDBP and HDAP in the aqueous phase was studied by solubility measurements in the absence of the organic phase. (B.L.M.)

9475 SOME OBSERVATION IN THE SOLVENT EXTRACTION OF ADDUCT METAL β-DIKETONATES WITH TRIBUTYLPHOSPHATE. Sekine, Tatsuya; Hasegawa, Yuko (Tokyo Coll. of Science). pp 691-3 of Progress in Coordination Chemistry. Cais, Michael (ed.). New York; American Elsevier Publishing Company, Inc. (1968).

From 11th International Conference on Coordination Chemistry, Haifa and Jerusalem, Israel. See CONF-680912-(Absts.).

The extraction of alkaline earth ions as chelates with benzoylacetone (BZA) and thenolytrifluoroacetone (TTA) and some of the properties of the adduct formation of these chelates with TBP in organic solvents were investigated. No complex or interaction was noted between TTA and TBP in $CHCl_3$ or CCl_4 at concentrations of TBP <0.1 M. The formation constants of bis-TTA–Sr(II) complex with TBP in CCl_4 were determined at several temperatures, and the heat of formation was determined from these constants at different temperatures to be 4.2 and 3.6 kcal/mole for the first and second adduct, respectively. The adduct formation constants and the extraction constants for Ca^{2+}, Sr^{2+}, Ba^{2+}, and Ra^{2+} with TTA–TBP mixtures in CCl_4 from 0.1 M $NaClO_4$ are tabulated. Concentrations of TBP > 0.1 M in the organic phase effected the extraction of metal perchlorates and mixed complexes. Equations are presented to describe the distribution ratio of metal ions if the concentration of TBP and ClO_4^- are kept constant. (B.L.M.)

9476 EXTRACTION OF ALKALI METALS IN THE PRESENCE OF MACROAMOUNTS OF $AuCl_4^-$ AND $FeCl_4^-$ WITH POLAR ORGANIC SOLVENTS. Maksimovic, Zoran; Kyrs, Miroslav (Boris Kidrich Inst. of Nuclear Science, Belgrade. Inst. of Nuclear Research, Rez, Czech.). pp 703-5 of Progress in Coordination Chemistry. /Cais, Michael (ed.). New York; American Elsevier Publishing Company, Inc. (1968).

From 11th International Conference on Coordination Chemistry, Haifa and Jerusalem, Israel. See CONF-680912-(Absts.).

The simultaneous distribution of the alkali metals and heavy metals in systems 6 to 10M in HCl with nitrobenzene or 2-nitropropane and containing $HFeCl_4$ or $HAuCl_4$ was investigated radiometrically at temperatures of 0, 15, 30, and 50°C. Values of the distribution coefficient for Cs as high as 10,000 were found. The reaction taking place was expressed by the equation $Cs^+_{aq} + Me^+_{org} \rightleftharpoons Cs^+_{org} + Me^+_{aq}$. The equilibrium constant was calculated for the reaction and found to be essentially independent of the chloro complex used, aqueous activity, or concentration of the chloro complex in the organic phase. Values of $K_{Cs/Me}$ (where Me denotes H, K, or Rb) increase in the series Rb, K, H, and the values for one fixed pair of ions always are higher for nitrobenzene than for 2-nitropropane and rise with decreasing temperatures. (B.L.M.)

9477 SOLVENT EXTRACTION OF 3-NITRO-p-CRESOL-5-SULPHONATE COMPLEXES OF TETRAVALENT PLUTONIUM AND HEXAVALENT URANIUM WITH TRIBUTYLPHOSPHATE. Beran, M. (Inst. of Nuclear Research, Rez, Czech.). pp 709-11 of Progress in Coordination Chemistry. /Cais, Michael (ed.). New York; American Elsevier Publishing Company, Inc. (1968).

From 11th International Conference on Coordination Chemistry, Haifa and Jerusalem, Israel. See CONF-680912-(Absts.).

The distribution of Pu(IV) and U(VI) complexes of 6-hydroxy-5-nitro-m-toluenesulfonic acid between 1M HCl and a dodecane solution of TBP at constant ionic strength at 25°C was found to increase with decreasing acidity of the aqueous phase suggesting that the ligand in the extracted complexes is the double charged A^{2-}. The complexes PuA_2 and UO_2A in the organic phase seem to be solvated by 3 and 2 molecules, respectively. (B.L.M.)

9478 PRIMARY AMINE EXTRACTION OF TARTARIC- AND MALONIC ACID AND THEIR RARE EARTH COMPLEXES. Kuiper, D. (Reactor Instituut, Delft, Netherlands). pp 725-6 of Progress in Coordination Chemistry. /Cais, Michael (ed.). New York; American Elsevier Publishing Company, Inc. (1968).

From 11th International Conference on Coordination Chemistry, Haifa and Jerusalem, Israel. See CONF-680912-(Absts.).

Malonic and tartaric acids and their rare earth complexes can be extracted by primary amines. The rare earth extraction was studied in several systems. (M.C.G.)

9479 EFFECT OF TBP DEGRADATION OF THE EXTRACTION PERFORMANCES. Faugeras, Pierre; Talmont, Xavier (CEA, Paris). pp 727-8 of Progress in Coordination Chemistry. /Cais, Michael (ed.). New York; American Elsevier Publishing Company, Inc. (1968).

From 11th International Conference on Coordination Chemistry, Haifa and Jerusalem, Israel. See CONF-680912-(Absts.).

The effects of TBP degradation in irradiated fuel reprocessing plants are discussed briefly. Various remedies for the conditions are considered. Tests carried out in shielded cells with solutions of up to 1000 Ci/l in which degeneration was avoided are described very briefly. (B.L.M.)

9480 A STUDY ON AMERICIUM/CURIUM RECOVERY FROM FUEL REPROCESSING HIGH LEVEL WASTE SOLUTIONS. Koch, Guenter (Kernforschungszentrum, Karlsruhe, Ger.). pp 729-30 of Progress in Coordination Chemistry. /Cais, Michael (ed.). New York; American Elsevier Publishing Company, Inc. (1968).

From 11th International Conference on Coordination Chemistry, Haifa and Jerusalem, Israel. See CONF-680912-(Absts.).

A flowsheet is described for the separation of the first cycle aqueous waste arising from Purex-type process for high burnup fuels from power reactors fueled with highly enriched U or with Pu. The waste is cooled long enough to allow for the decay of the main decay heat producers. After concentration by evaporation and denitration the waste is adjusted with a base and with a complexing agent (e.g. citrate) to produce the feed for the first extraction cycle. Americium and Cm are extracted along with the rare earths by bis(2-ethylhexyl) phosphate diluted with a mixture of n-paraffins, modified by TBP. The Am and Cm are separated from the lanthanides by contacting the pregnant organic solution with an aqueous solution containing diethylenetriaminepentaacetic acid and lactic acid. (B.L.M.)

9481 FORMATION OF PRIMARY AND SECONDARY DEGRADATION PRODUCTS AND THEIR INFLUENCE ON THE EXTRACTION BEHAVIOR OF THE SYSTEM 20 PERCENT TBP-DODECANE. Stieglitz, Ludwig (Kernforschungszentrum, Karlsruhe, Ger.). pp 735-6 of Progress in Coordination Chemistry. /Cais, Michael (ed.). New York; American Elsevier Publishing Company, Inc. (1968).

From 11th International Conference on Coordination Chemistry, Haifa and Jerusalem, Israel. See CONF-680912-(Absts.).

Irradiation of mixed phases composed of 20% TBP-dodecane and HNO_3 in a 1:1 volume ratio showed enhanced formation of HDBP (dibutylphosphate) dependent on HNO_3 concentration as compared to results for irradiation of pure TBP in dodecane in a single phase. Diluent degradation and its influence on the retention of Zr were investigated in this system. The distribution coefficient was found to increase with increasing dose; and several days after irradiation, the D values increased by a factor of 6 to 8 indicating that from primary products as nitroparaffins and/or ketones potent extractants are formed even without radiation. (B.L.M.)

9482 A STUDY OF THE VARIATION OF THE SEPARATION-FACTOR FOR THE EXTRACTION OF Th^{4+} AND UO_2^{2+} WITH CHELATING AGENT AND ORGANIC SOLVENT. Jensen, Bror Skytte (Danish Atomic Energy Commission, Risoe). pp 737-9 of Progress in Coordination Chemistry. /Cais, Michael (ed.). New York; American Elsevier Publishing Company, Inc. (1968).

From 11th International Conference on Coordination Chemistry, Haifa and Jerusalem, Israel. See CONF-680912-(Absts.).

The extraction of tracer ^{234}Th from 0.1M aqueous solutions of aged $UO_2(NO_3)_2$ by 0.005M solutions of differently substituted 1-phenyl-3-methyl-4-acylpyrazolones and some types of chelating agents in $CHCl_3$ was determined. The trend of the data indicated that for a homologous series of extractants the smallest molecule will be likely to show the largest separation factor for the Th^{4+}/UO_2^{2+} couple. The optimum conditions for the isolation of ^{234}Th from aged $UO_2(NO_3)_2$ solutions are probably found with ethoxycarbonylpyrazolones in CCl_4. The method developed here for separation of trace activities of one component from macroamounts of an inactive material is applicable to other systems. (B.L.M.)

9483 SELECTIVE SEPARATION OF URANIUM IN AQUEOUS SOLUTION BY SOLVENT EXTRACTION. APPLICATION TO OBTAINING VERY PURE URANIUM SOLUTIONS. Boirie, C.; Platzer, R. (CEA, Saclay, France). pp 833-5 of Progress in Coordination Chemistry. /Cais, Michael (ed.). New York; American Elsevier Publishing Company, Inc. (1968). (In French).

From 11th International Conference on Coordination Chemistry, Haifa and Jerusalem, Israel. See CONF-680912-(Absts.).

Conditions for the extraction of uranium and elements such as Zr, Th, Al, Fe, and Pu using aliphatic long chain amines, preferably triisooctylamine, are described. The conditions of extraction were studied as a function of acidity of the aqueous phase of nitric, hydrochloric, and sulfuric acids. (P.C.H.)

9484 CLINICAL CHEMISTRY OF THE TIN-INDIUM GENERATOR. Penkoske, P. (Washington Univ., St. Louis); Potchen, E. J.; Welch, M. J.; Welch, T. J. J. Nucl. Med.; 10: 646-50(Oct 1969).

Equilibrium constants for ^{113m}In-labeled indium as obtained from the Sn-In generator were measured using the batch ion exchange method. The values obtained using 0.05M chloride (HCl) as the eluting solution were: $In(H_2O)_6^{3+}$ = 5.85%; $In(H_2O)_5Cl^{2+}$ = 80.5%; $In(H_2O)_4Cl_2^{+}$ = 11.65%; and $In(H_2O)_3Cl_3$ = 2.00%. This information is an essential prerequisite to meaningful chemical manipulation of the eluate in preparation of organ specific radiopharmaceuticals. On the basis of these data, simplified methods using prepared vials are being developed for brain, kidney, lung, liver, spleen, bone marrow, and blood-pool scanning agents. (P.C.H.)

9485 RAPID ION EXCHANGE SEPARATIONS. CHROMATOGRAPHIC LANTHANIDE SEPARATIONS USING A HIGH-PRESSURE ION EXCHANGE METHOD. Campbell, David O.; Buxton, Samuel R. (Oak Ridge National Lab., Tenn.). Ind. Eng. Chem., Process Design Develop.; 9: 89-94(Jan 1970).

Application of a high-pressure ion exchange system was demonstrated by separating adjacent lanthanide elements by chromatographic elution from Dowex 50 resin. The ion exchange system utilizes very finely divided ion exchange resin in relatively long columns, and a high pressure is necessary to achieve reasonable flow rates. Satisfactory elutions were obtained at high flow rates, up to 29 ml per cm^2 per min, resulting in rapid separations, in less than 1 hr on the 100-mg scale. Resin loadings were demonstrated at flow rates up to 50 ml per cm^2 per min. The effects of flow rate, resin loading, eluent composition, and temperature were investigated. Good products were obtained, as long as only a small percentage of the resin was loaded with lanthanides. Flow rate had relatively little effect on band width and separation. The equipment developed and the operating procedures defined are directly applicable to the separation of transcurium elements at the maximum production rate anticipated at ORNL in the near future. (auth)

9486 RAPID ION EXCHANGE SEPARATIONS. CHROMATOGRAPHIC SEPARATION OF TRANSPLUTONIUM ELEMENTS USING HIGH PRESSURE ION EXCHANGE. Campbell, David O. (Oak Ridge National Lab., Tenn). Ind. Eng. Chem., Process Design Develop.; 9: 95-9(Jan 1970).

The high pressure ion exchange method, utilizing very finely divided resin, a high pressure drop, and large flow rates, was demonstrated by separating the six transplutonium elements, americium, curium, berkelium, californium, einsteinium, and fermium, using chromatographic elution from Dowex 50-X12 resin with α-hydroxyisobutyric acid. All the actinides were separated in good yields and purities in times as short as 1 hour. Product yields were generally better than 99% with substantially less than 1% impurity from other actinides. Purity is limited ultimately by tailing of the elution bands at concentrations about one 1000th of their peak concentrations. Berkelium was not separated from europium. The high pressure system is advantageous for processing highly radioactive materials because the high flow rate permits reduced exposure time, the high pressure controls bubble formation from radiolytic gas, and the improved resolution yields excellent separations. (auth)

EARTH SCIENCES

Geology and Hydrology

Refer also to abstracts 9252, 9423–9426, 9543, 9546, 9605, 9696, 9701, and 9730.

9487 (BNWL-1228) EVALUATION OF THE SIMPL-1 HYBRID COMPUTER CONCEPT ON A WATER QUALITY BENCHMARK PROBLEM. Burnett, R. A.; Daniels, D. G. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Nov 1969. Contract AT(45-1)-1830. 28p. Dep. CFSTI.

As part of a study to evaluate the Battelle–Northwest SIMPL-1 hybrid computer concept in comparison to large digital techniques, a hybrid version of an all-digital Columbia River water quality simulation was developed. The discrete-time, discrete-space digital water transport model was transformed into a continuous-time, discrete-space analog model for use in the hybrid program. Identical river and weather parameters were input to both models for a performance comparison. The hybrid results matched the all-digital output almost exactly. A minimum speed advantage of 3.6 to 1 and a machine economic advantage of 55 to 1 was achieved by the SIMPL-1 hybrid program over the all-digital program. Although requiring longer initial setup time, the hybrid program eliminated turnaround time between successive runs and provided the operational conveniences of man-machine interaction and graphical output displays. (auth)

9488 (SZS-6/69) SORPTION OF RADIONUCLIDES ON FRIABLE SOILS AND OTHER NATURAL ABSORBENTS. Johannsen, K.-H.; Lenk, W. (Staatliche Zentrale fuer Strahlenschutz, Berlin (East Germany)). Jul 1969. 33p. (In German). Dep. CFSTI (U. S. Sales Only).

The decontamination efficiency of 5 typical soils, browncoal, and sawdust was investigated for waters containing radionuclides. The dependence on pH, carrier concentration, and time of the distribution ratios of ^{144}Ce, ^{137}Cs, ^{131}I, ^{106}Ru, ^{89}Sr, ^{60}Co, and fission products was determined by shaking. The highest distribution ratios (100 to 1000) were obtained with soils containing clay or humic acids. The pH was of no important influence on the adsorption in the pH range 4 to 10. On the average the highest distribution ratios were obtained in this range. The strength of adsorption decreased in the following order: RE > Sr > Cs > Ru > I. The results show that with soils, even in amounts of 10 to 100 g/l, it is not possible to get decontamination effects in the order of magnitudes. Moreover it is difficult to handle soils in water treatment plants. In accidental situations however waste disposal into the ground is more convenient than disposal into surface waters. (auth)

9489 (TID-25284) ISOTOPIC STUDIES OF ATMOSPHERIC METHANE, ETHANE, AND KRYPTON. Haines, Alan Everett (Arkansas Univ., Fayetteville). 1968. Contract AT(40-1)-3192. 57p. Dep. CFSTI.
Thesis.

The level of tritiated methane in the atmosphere has remained essentially constant during the period 1958 to 1967. The continuing release needed to maintain this level can easily be accounted for by release from nuclear industry. The detection of tritiated ethane is strong support for the source of the tritiated methane being used in nuclear industry. The krypton-85 level in the atmosphere did not appear to be as high as previously thought. Three samples were obtained which may represent a well mixed global atmosphere. From these a ^{85}Kr level of 240 dpm/mMole for the atmospheric krypton was obtained. Ethane was recovered carrier free and found to have a tritium level comparable to that of methane. The stable isotopes ratios were similar to those measured in atmospheric methane. (auth)

9490 (TID-25285) TRITIUM IN ATMOSPHERIC HYDROGEN AND ATMOSPHERIC WATER. Layton, Bobby Ray (Arkansas Univ., Fayetteville). 1969. 62p. Dep. CFSTI.
Thesis.

Atmospheric hydrogen and rainwater samples were examined to determine the T/H ratios, and to evaluate, if possible, the validity of the application of the D/H corrections to the observed T/H data for the atmospheric hydrogen samples. The general trend of the isotopic ratios for the period 1963 to 1966 was obtained by plotting the D/H and T/H ratios versus the collection date of the sample. The T/H ratios fluctuated during the four year period, but the tritium peaks were highest in late 1964 and early 1965. This report is Appendix III to TID-25284, Isotopic Studies of Atmospheric Methane, Ethane, and Krypton. (J.C.W.)

9491 (TID-25286) RELATIONSHIPS AMONG ATMOSPHERIC FORMALDEHYDE, METHANE, AND KRYPTON. Shearer, Edmund Cook (Arkansas Univ., Fayetteville). 1969. 141p. Dep. CFSTI.
Thesis.

Atmospheric samples were routinely collected over a period of 10 months at an urban and rural sampling site for methane concentration measurements. Lower than other reported measurements, the rural samples averaged 0.89 ppM by volume while the urban samples averaged 1.26 ppM. Fluctuations are due to the production rate of methane, civilization, and meteorological conditions. Based on these data, a new production rate of methane was calculated to be 3.3×10^{14} g/yr, the atmosphere's methane inventory was calculated to be 3.4×10^{15} g, and the lifetime of methane was calculated to be about 10 years by two different methods. Rain was found to be an extremely efficient scavenger of formaldehyde. Rain samples containing formaldehyde were routinely collected and measured for the concentration of formaldehyde and for the tritium content of formaldehyde. The average formaldehyde concentration is 0.75 mg/l while formaldehyde contains 4×10^4 T. U. Using available spectral data, a lifetime of 1.67 days was obtained for formaldehyde. Because this will be a major source of hydrogen that has not yet been treated, marked revision is recommended. That formaldehyde has a tritium content like that of atmospheric methane is strong evidence that the undiscovered tropospheric sink of methane is incomplete oxidation to formaldehyde. For a period of more than a year, methane and krypton were collected over a 24 hour period in a rural area for isotopic studies. The T/H ratio for methane generally ranged from 1 to 5×10^4 T. U., strengthening the proposal that continuous nuclear industrial release in the northern hemisphere is just balancing the radio and chemical destruction of tritiated methane. The krypton data points fall between 300 and 500 dpM/mM with two measurements falling much below the normal scatter. These points may well represent the krypton-85 activity of well mixed atmosphere as 200 dpM/mM, with the unmixed air masses causing fluctuation in the cited range. A correlation between krypton-85 activity and the T/H ratio in methene is demonstrated. This report is Appendix II to TID-25284, Isotopic Studies of Atmospheric Methane, Ethane, and Krypton. (auth)

9492 (UCRL-50750) DETERMINATION OF ACOUSTIC VELOCITIES AND DYNAMIC ELASTIC MODULI IN ROCKS UNDER PRESSURE. Schock, R. N.; Louis, H.; Lilley, E. M. (California Univ., Livermore. Lawrence Radiation Lab.). 18 Sep 1969. 38p. Dep. CFSTI.

A fundamental need of the Plowshare and Whitney Test Programs is the capability to predict the effects from the detonation of a buried explosive. To adequately predict these effects, a reasonable equation-of-state must be obtained. As part of this program, acoustic velocities were measured and elastic moduli was computed. The theory of elastic strain in an isotropic medium relates the acoustic velocities and the elastic moduli in such a manner that a determination of the compressional and shear velocities is sufficient to allow the calculation of all elastic properties. These measurements were made as a function of confining pressure up to 10 kb to provide insight into the response of the rock medium to a stress wave. To determine the velocity of propagation, an audio signal was generated by applying an electrical pulse to a transducer; the time necessary for this signal to traverse the cylindrical rock specimen and activate another transducer was measured. (auth)

9493 (USGS-474-48) SOME PHYSICAL PROPERTIES OF ROCKS IN DRILL HOLE UAe-1, AMCHITKA ISLAND, ALASKA. Amchitka 6-2. Lee, William H. (Geological Survey, Denver, Colo.). Sept. 1969. Contract AT(29-2)-474. 14p. Dep. CFSTI.

Physical properties of rocks from drill hole UAe-1 were analyzed by averaging and minimum-maximum ranging. Two sources of data were Birdwell 3-D log computations and USGS laboratory determinations. Rocks in the drill hole were divided into seven separate lithologic types for purposes of analysis. The physical properties of similar lithologic types were compared with the conclusion that alteration significantly changed the properties of the rock. (auth)

9494 (USGS-474-51) PRELIMINARY LITHOLOGIC LOG OF DRILL HOLE UAe-3 FROM 4,800 TO 7,012 FEET, AMCHITKA ISLAND, ALASKA. Amchitka 8-1. Lee, William H. (Geological Survey, Denver, Colo.). Sep 1969. Contract AT(29-2)-474. 5p. Dep. CFSTI.

Drill hole UAe-3 was drilled to a total depth of 7,012 feet. The major rock types penetrated by the drill hole are volcanic breccia, basaltic lava, volcanic sandstone, and siltstone. Structural data indicate that the site is unfavorable for the detonation of an underground nuclear test owing to the presence of a large high-angle fault zone in the interval between 5,680 and 6,088 feet. Based on this knowledge, emplacement hole UA-3 was discontinued at 531 feet. (auth)

9495 A COMMENT ON THE CONCORDIA METHOD OF INTERPRETING WHOLE-ROCK U/Pb RATIOS. Ulrych, T. J. (Univ. of British Columbia, Vancouver). Earth Planet. Sci. Lett.; 7: 116-18(Nov 1969).

Comments are made on the criticism of Oversby and Gast concerning the use of the Concordia diagram in interpreting whole-rock U/Pb ratios. (auth)

9496 ^{210}Pb AND ^{226}Ra DISTRIBUTION IN SOME SOILS. Vilenskii, V. D. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Geokhimiya; No. 12, 1507-10(Dec. 1969). (In Russian).

Studies of ^{210}Pb and ^{226}Ra distribution in soil specimens taken from four vertical sections in two districts of European USSR territory, showed that (calculated as air-dry specimens) the ^{210}Pb content was within the range of ~0.1 to 7.7 nCi/g and ^{226}Ra was 0.1 to 2.2 nCi/g. In the lower levels the ^{210}Pb content in soil was identical to the ^{226}Ra content, while in the upper levels it exceeded the ^{226}Ra content. The higher ^{210}Pb content indicated that the actual fallout was within 6.5 to 42.3 nCi/m^2 per day with the mean of 22 nCi/m^2 per day. (R.V.J.)

9497 RADIOACTIVITY OF MINERALS OF SOME ULTRA-BASIC ROCKS OF THE USSR. Cherdyntsev, V. V.; Senina, N. I.; Kuzmina, E. A. (Geological Inst., Moscow). Geokhimiya; No. 12, 1434-8(Dec 1969). (In Russian).

Data are given on the content of uranium, thorium isotopes (thorium-232, ionium, and radiothorium), and plutonium in 22 samples of ultrabasic rocks of the USSR. The average uranium content varied in separate regions from 10^{-8} g/g to 10^{-7} g/g at a somewhat lowered thorium-uranium ratio (on the average about 2.5) which was explained by uranium enrichment during metasomatic rock alteration. In most uranium samples the transuranium α-emitter (4 to 4.7 MeV) was detected, the probable parent of ^{239}Pu. Its activity was apparently higher than the plutonium activity (the maximum content of which does not exceed $2.9 \cdot 10^{-11}$%), which may be caused by the position of the isotope on the lateral branch of decay. In mineral bodies an excess of radiothorium, a product of mesothorium (radium isotope) was frequently observed which obviously had been carried in by natural waters from waters from surrounding rocks with higher activity. (auth)

9498 A CONSIDERATION ON THE INITIAL STRONTIUM ISOTOPIC COMPOSITION IN GRANITES. Kagami, Hiroo (Tokyo Univ.). Ganseki Kobutsu Kosho Gakkaishi; 62: No. 1, 36-43(Jul 1969). (In Japanese).

It has been generally accepted that granites having relatively high initial strontium composition (initial ^{87}Sr/^{88}Sr) were formed either by remelting of sialic crustal rocks or by contamination of crystal materials in magmas of mantle-type materials origin. However, it seems to be necessary to reexamine such an idea. A model is proposed for deriving granites having high initial strontium composition, without the participation of sialic crystal materials. In this model it is conceived that magmas generated from the upper mantle materials with low Rb/Sr and low ^{87}Sr/^{86}Sr values are brought to a halt there or nearby deep place for 10^7 yr or longer, and then invade into the crust and are differentiated into various granites. It is hoped that the validity of the above concept may be examined by further studies. (auth)(NSA of Japan)

9499 NUCLEAR PHYSICS IN GEOLOGY. Alekseev, F. A. Tr., Vses. Nauch.-Issled. Inst. Yadern. Geofiz. Geokhim.; No. 1, 3-19(1968). (In Russian).

The main achievements of the USSR in the field of nuclear geophysics in recent years are reviewed. These include theoretical investigations and the practical use of nuclear physics in geology. In addition to radioactivity logging, the practical applications include photonuclear methods of investigating samples in the laboratory and rocks and ores in place, and the analysis of rocks and ores by x-ray radiometric methods and with the aid of the Moessbauer effect. (Geophys. Abstr.)

9500 URANIUM, THORIUM, AND LEAD SYSTEMATICS IN GRANITE MOUNTAINS, WYOMING. Rosholt, J. N.; Bartel, A. J. (Geological Survey, Denver). Earth Planet. Sci. Lett.; 7: 141-7(Nov 1969).

Uranium, thorium, and lead concentrations and isotopic compositions were determined on total rocks and a feldspar sample from widely separated parts of the Granite Mountains in central Wyoming. Linear relations defined by ^{206}Pb/^{204}Pb–^{207}Pb/^{204}Pb and ^{208}Pb/^{204}Pb–^{232}Th/^{204}Pb for the total rock samples define 2.8 billion-year isochrons. In contrast, ^{238}U/^{206}Pb ages are anomalously old by a factor of at least four. The low ^{238}U/^{204}Pb values, coupled with the radiogenic ^{206}Pb/^{204}Pb and radiogenic ^{207}Pb/^{204}Pb ratios, indicate that contents of uranium in near-surface rocks would have had to have been considerably greater than those presently observed to have generated the radiogenic lead. It is possible that more than 10^{11} kg of uranium has been removed from the Granite Mountains, and the most feasible interpretation is that most of this uranium was leached from near-surface rocks at some time during the Cenozoic, thus providing a major source for the uranium deposits in the central Wyoming basins. (auth)

9501 ROLE OF NUCLEAR FISSION IN HEAT GENERATION ON THE EARTH. Shukolyukov, Yu. A. (Inst. of Geology and Geochronology of the Precambrian, Leningrad). Geokhimiya; No. 12, 1424-33(Dec 1969). (In Russian).

From uranium-238, uranium-235, and thorium-232 abundance on the earth the amount of energy released during spontaneous fission of these isotopes for 5.10^9 years was calculated. This energy was ~10^6 times less than the amount of heat formed during α-, β-, and K-decay of natural radioelements. The isotopic composition of primordial xenon was estimated for the calculation of the fission component in atmospheric xenon. In atmospheric xenon 3.3% was formed during spontaneous fission of the hypothetic transuranium element. The xenon yield during fission is accepted to be 18 ± 5%. The energy amount released during fission of this transuranium exceeds 10 times the amount of heat formed during spontaneous fission of uranium-238 for the time of the earth crust existence. However, in the total generation of radioactive heat transuranium fission has given a negligibly little energy amount. (auth)

9502 ATOMIC ENERGY BOARD COMPLETES SECOND FIVE-YEAR PROGRAM. S. Afr. Mining Eng. J.; 80: 1429-31 (27 Jun 1969).

Effort was concentrated on nuclear fuel development; the Bufflex project and the Purlex process were demonstrated, and many U-producing companies are planning to introduce the latter, with 7 plants in operation by 1971. At Pelindaba much time was devoted to raising the power of the Safari reactor to the design figure of 20 MW. The following geologic formations were investigated: metaquartzite bands in the Archaic complex near Messian, Northern Transvaal, which showed values to a maximum of 0.02% U_3O_8 and 0.234% ThO_2; pegmatite intrusions along faults in the Pietersburg district, where the U content was low; conglomerate reefs in the Swartrif Series of the Transvaal System which in places showed as much as 0.15% U_3O_8; conglomerate reefs in the Godwan and Mozaan Formations along the escarpment of the Eastern Transvaal, in which only low U values were found; and various conglomerate reefs in the Dominion Reef System in the Western Transvaal. Aerial radiometric anomalies were found to be caused by the following rock types: radioactive heavy minerals, which occurred in drift sand along some of the larger rivers near the coast; dome-shaped granite intrusions rich in K felspar; and a Fe–Mn deposit in which a radioactive mineral was present. Tests were conducted to improve the acid leaching of U. Work was also continued on methods for manufacturing UF_4, UF_6, UO_2 pellets, and other U ceramic fuel compounds. Fundamental studies in physics, chemistry, and solid-state science are listed. (BBB)

9503 SHOCK AND THERMAL METAMORPHISM OF BASALT BY NUCLEAR EXPLOSION, NEVADA TEST SITE. James, Odette B. (Geological Survey, Washington, D. C.). Science; 166: 1615-20(26 Dec 1969).

Olivine trachybasalt metamorphosed by nuclear explosion was classified into categories of progressive metamorphism: Weak-plagioclase was microfractured, and augite contained fine twin lamellae; moderate-plagioclase was converted to glass, and mafic minerals showed intragranular deformation (undulatory extinction, twin lamellae, and, possibly, deformation lamellae), but rock texture was preserved; Moderately strong-plagioclase glass showed small-scale flow, mafic minerals were fractured and showed intragranular deformation, and rocks contained tension fractures; Strong-plagioclase glass was vesicular, augite was minutely fractured, and olivine was coarsely fragmented, showed mosaic extinction, distinctive lamellar structures, and was locally recrystallized; and Intense-rocks were converted to inhomogeneous basaltic glass. (auth)

9504 FIRST RESULTS OF TESTING OF THE PULSED NEUTRON–NEUTRON METHOD IN THE CONDITIONS OF THE OIL

AND GAS FIELDS OF KRASNODAR TERRITORY. Bespalov, D. F.; Kitsenko, Yu. A.; Konoplev, Yu. V.; Romanovskii, V. F. Tr., Vses. Nauch.-Issled. Inst. Yadern. Geofiz. Geokhim.; No. 1, 170-6(1968). (In Russian).

Preliminary results indicate the broad possibilities of using the pulsed neutron–neutron method to bring out the water–oil and gas–liquid interfaces in oil fields of the Krasnodar Territory. (Geophys. Abstr.)

9505 DETERMINATION OF THE POROSITY OF LIMESTONE FORMATIONS FROM THE MASTER CURVES OF NEUTRON–GAMMA LOGGING. Kukharenko, N. K.; Basin, Ya. N. Tr., Vses. Nauch.-Issled. Inst. Yadern. Geofiz. Geokhim.; No. 1, 215-26(1968). (In Russian).

At present most geophysical organizations are not using neutron-gamma logging enough to obtain data on the porosity of carbonate formations. Recommendations for improving the quality of operation and interpretation of neutron-gamma logging which should remedy this deficiency are given. (Geophys. Abstr.)

9506 NUCLEAR TECHNIQUES IN PROBLEMS CONNECTED WITH THE WATER SUPPLY OF SOIL AND PLANTS. Marcesse, J. (CEN, Cadarache, France). Bull. Inform. Sci. Tech. (Paris): No. 141, 11-20(Oct 1969). (In French).

The development of nuclear techniques in France for the measurement of moisture in situ and for research on the behavior of water in agricultural soils is only beginning. So far the only application is the use of neutron moisture gages. Detailed theoretical studies have solved the problem of calibration and enabled the potentialities of the method to be explored. Several tens of instruments are in operation on assignments as varied as the knowledge of laws governing the filling and emptying of soils, the contribution of soil moisture storage towards crop consumption, and irrigation control. Gamma radiation is used to measure soil density in situ and to study the movement of water on laboratory models. (auth)

9507 ATTEMPT TO USE THE BOREHOLE NEUTRON PULSE GENERATOR OF THE PULSED NEUTRON–NEUTRON LOGGING METHOD ON THE OIL FIELDS OF TATARY. Blankov, E. B.; Kurilenko, F. A. Tr., Vses. Nauch.-Issled. Inst. Yadern. Geofiz. Geokhim.; No. 1, 160-5(1968). (In Russian).

It was shown that conducting pulsed neutron-neutron logging in all wells of a field such as the Romashkino would constitute a real scientific and technological revolution in the monitoring of that field during development. However, work by this method can be accomplished at present only in a relatively small number of standing wells. It will be possible to investigate more wells only when a miniaturized borehole pulsed neutron generator 45 mm in diameter is built, suitable for operating in active wells through the pump–compressor pipes. (Geophys. Abstr.)

9508 STRONTIUM ISOTOPES IN WEATHERING PROFILES, DEEP-SEA SEDIMENTS, AND SEDIMENTARY ROCKS. Dasch, E. Julius (Yale Univ., New Haven). Geochim. Cosmochim. Acta; 33: 1521-52(Dec 1969).

Modifications in the rubidium–strontium–strontium isotope system during low-temperature geologic processes were determined for major lithic units. Rubidium–strontium ratios in basalt and granite increase markedly during weathering, but strontium isotopic composition is not altered significantly in many profiles. These relations may be useful in distinguishing active and relict weathering profiles. Deposition of aluminosilicate detritus in the marine environment may result in a further increase of rubidium–strontium ratios for the ditritus, owing to rubidium fixation. Strontium in even the finest fraction of aluminosilicates deposited in the ocean, however, apparently does not equilibrate with marine strontium, even after prolonged contact with sea water and interstitial marine water. Thus the isotopic composition of strontium in deep-sea sediments may be used as an indicator of geologic provenance. Diagenesis of aluminosilicates does not generally result in equilibration of strontium isotopes, except possibly after the sediment has been deeply buried. This lack of strontium isotope equilibration during low-temperature processes places constraints on the dating of sediments and sedimentary rocks by the rubidium–strontium method. (auth) (UK)

9509 PROGRESS IN ISOTOPIC HYDROLOGY: THE COMBINED ENVIRONMENTAL ISOTOPE APPROACH. Bowen, R. (International Atomic Energy Agency, Vienna). Sci. Progr. (Oxford); 57: 559-75(1969).

The application of environmental isotope studies to hydrologic and hydrogeologic investigations is described, the term environmental being used for isotopes whose natural abundance variations may be usefully used in this connection, for example deuterium, ^{18}O, tritium, and ^{14}C. Employment of all or a number of these comprises the combined environmental isotope approach. After theoretical discussions practical examples are given with reference to ground and surface water. This approach is claimed to be cheaper and more rapid than other methods, and is being used in a number of United Nations projects in Africa. (UK)

9510 USE OF PULSED NEUTRON–NEUTRON LOGGING IN THE OIL FIELDS OF THE UKRAINE. Belli, G. P.; Polushanskii, A. A.; Trum, A. D. Tr., Vses. Nauch.-Issled. Inst. Yadern. Geofiz. Geokhim.; No. 1, 165-70(1968). (In Russian).

It was shown that pulsed neutron-neutron logging was more sensitive to variations in lithology and saturation of reservoir formations than other radiometric methods. With this method it was possible to determine the water–oil and gas–oil interfaces reliably and to follow their advance during exploitation of the field, where salinity of the formation waters was low (100 to 150 g/l NaCl). Pulsed neutron-neutron logging can be used to bring out oil- and gas-bearing objects in exploratory wells after they are cased. (Geophys. Abstr.)

9511 DETERMINATION OF THE SOURCE OF FLOODING OF OPERATING WELLS BY AN ACTIVATION METHOD. Blankova, T. N. Tr., Vses. Nauch.-Issled. Inst. Yadern. Geofiz. Geokhim.; No. 1, 205-9(1968). (In Russian).

An activation method used in the Tatar A.S.S.R. to determine the source of flooding in wells, based on the change in rate of the drop in induced activity of Na upon movement of water containing that element is described. The advantage this method has over all others is the possibility of using it in conditions where the others cannot be applied, particularly in wells where the pressure in the formations yielding the water is considerably greater than that in the formations through which the radioactive isotopes must be injected. The activation method also can be used to investigate wells in which the formation yielding the water is itself not accessible for investigation. An important merit is that the well is not contaminated by radioactive matter. (Geophys. Abstr.)

9512 RESULTS OF CALCULATION OF THE SPACE–TIME DISTRIBUTION OF NEUTRONS IN HOMOGENEOUS SANDSTONE OF VARIED POROSITY BY A MONTE CARLO METHOD. Denisik, S. A.; Rezanov, R. A.; Lukhminskii, B. E. Tr. Vses. Nauch.-Issled. Inst. Yadern. Geofiz. Geokhim.; No. 1, 106-30(1968). (In Russian).

The results are tabulated for the computation of the space time distribution of neutrons in sandstones with 5, 10, and 20 percent porosity, saturated with fresh and with salt water; in dry sandstone; and in fresh and salt water. A sodium chloride solution (200 g per l) was used as the salt water. (Geophys. Abstr.)

9513 DEPENDENCE OF THE RESULTS OF PHOTONEUTRON MEASUREMENTS ON BERYLLIUM IN ORES IN PLACE ON THE PHYSICAL PROPERTIES OF THE ORES AND SOME CONDITIONS OF MEASUREMENT. Shishakin, O. V. Tr., Vses. Nauch.-Issled. Inst. Yadern. Geofiz. Geokhim.; No. 1, 279-86(1968). (In Russian).

The effect of the physical properties of the ore and conditions of measurement on the results of measuring the difference in slowing-down and absorption of neutrons by ores, and also of the thickness of the layer of material filling the borehole are described. The models, apparatus, and processing of results of measurements are described briefly. The dependence on hydrogen content, effects of neutron absorption in the ore, and effects of thickness of the water layer in the borehole are discussed. The results suggest the expediency of using a neutron retarder layer 1.5 cm thick around the detectors in photoneutron investigations on the surface of an ore body, and cartridges of large diameter (90 to 100 mm) without internal neutron retarder in investigations in water-filled boreholes. (Geophys. Abstr.)

9514 CALCULATION BY A MONTE CARLO METHOD OF THE DISTRIBUTION OF PHOTONEUTRONS FROM A BEAM OF GAMMA RADIATION WITH INITIAL ENERGIES OF 4.1 MeV. Berzin, A. K.; Denisik, S. A.; Lukhminskii, B. E. Tr., Vses. Nauch.-Issled. Inst. Yadern. Geofiz. Geokhim.; No. 1, 234-41 (1968). (In Russian).

Results of calculations made by a Monte Carlo method of the distribution of photoneutrons in rocks of different porosities are presented. If photoneutrons from ^{9}Be are regarded as noise, the determination of deuterium in rocks in an approximately uniform medium by the photoneutron method with initial energies of the gamma radiation of 4.1 MeV proves to be a low-background measurement. With increasing porosity the signal-to-noise ratio increased hyperbolically, as the concentration of deuterium increased linearly and the concentration of Be dropped off linearly. (Geophys. Abstr.)

9515 TRANSPORT OF WATER AWAY FROM A BURIED HEAT SOURCE WITH SPECIAL REFERENCE TO HYDROLOGIC

PHENOMENA OBSERVED AT AARDVARK NUCLEAR DETONATION. Reed, Walter E. (Univ. of California, Berkeley). J. Geophys. Res.; 75: 415-30(10 Jan 1970).

The structural relationship between thermoelectric and electrokinetic phenomena resulting from a thermal anomaly in geologic media is examined in detail using nonequilibrium thermodynamics. As a result of this investigation, the following conclusions are advanced: Detonation of an underground nuclear device establishes a thermo-electro-kinetic couple causing water to flow radially away from the detonation site. This is considered to be the cause of hydrologic phenomena associated with the Aardvark event. Electrical potentials established by the heat source will cause cationic rearrangements, with the cations migrating radially away from the anomaly. In the vicinity of a nuclear detonation, the migration rates are probably small; however, experimental verification is necessary. Finally, it is urged that the phenomenological coefficients, which are pure functions of the geologic medium, should be routinely measured and evaluated whenever a situation involving a buried heat source is encountered. (auth)

9516 RADIOGENIC HEAT PRODUCTION IN PREBATHOLITHIC ROCKS OF THE CENTRAL SIERRA NEVADA. Wollenberg, Harold A.; Smith, Alan R. (Univ. of California, Berkeley). J. Geophys. Res.; 75: 431-8(10 Jan 1970).

Likely source material for the Sierra Nevada batholith is represented by exposures of Paleozoic rocks on the western flanks of the Sierra Nevada, Paleozoic sedimentary rocks in roof pendants east of the Sierran crest, and both Precambrian and Paleozoic rocks in the western portion of the Basin and Range province. The radiogenic heat production of these rocks was calculated from γ-radiometric determinations of their U, Th, and K contents. The abundances of these radioisotopes in carbonate rocks were roughly an order of magnitude lower than those in adjacent siliceous sedimentary rocks; therefore, the radiogenic heat production in the Paleozoics depended mainly on the relative amounts of carbonate and siliceous material. Heat production varied from east to west, with weighted values (expressed in units of μcal/g yr) of 3.7 in Precambrian rocks of the Death Valley area, 3.5 in Paleozoics of the Inyo and White mountains, 3.8 in Paleozoic pendants, and 2.1 in rocks of the Calaveras formation on the western slope. A difference, similar to that in the Paleozoics, was observed between Mesozoic rocks exposed near the crest (4.4) and the Mesozoics of the western foothills (2.4). The geographic distribution of heat production matched (though not proportionally) that in the batholithic rocks. This suggests that there was a regional distribution of radioactivity in likely source material for the granitic rocks that now, strongly accentuated by the effects of erosion, is reflected in the batholith. (auth)

9517 EXCESS RADIOGENIC ARGON IN PEGMATITE MINERALS. Laughlin, A. William (Univ. of Arizona, Tucson). J. Geophys. Res.; 74: 6684-90(15 Dec 1969).

The unreliability of plagioclase and spodumene from the plutonic environment for K–Ar dating is demonstrated. Data and information from the literature indicate that in eight out of twelve pegmatites, plagioclase yielded K–Ar apparent ages older than the cogenetic micas. Spodumene samples from three pegmatites gave erratic results: one approximating the true age, one too young, and one too old. The quantities of excess ^{40}Ar incorporated by the plagioclase were not constant but increased with the true age of the sample in accordance with the previously recognized excess inert gas age effect. (auth)

9518 RADIOISOTOPE MEASUREMENTS OF GROUND WATER VELOCITIES AND THEIR DIRECTIONS. Islam, Habibul; Choudhury, M. I.; Khan, Rafidul Islam; Mazid, Abdul (Atomic Energy Centre, Dacca, Pakistan). Nucleus (Lahore); 6: 120-3(Apr-Jun 1969).

Measurements of velocity and direction of water moving through medium grained sands in a model have been performed by a single well technique using a radioactive isotope as a tracer and with various percentages of openings in the filter tubes. At about 15% opening, the filter tube seemed to be ideal for velocity—10^{-4} cm/sec. Special attention was given to diffusion of tracer solution which is prominent at and below the above velocity. It has been observed that if the loss of tracer due to diffusion is accounted for, the method gives accurate results. Direction measurement is almost independent of diffusion, but at very low velocity it also affects the accuracy. (auth)

9519 RADIOACTIVITY TRANSPORT IN WATER: INTERACTION BETWEEN FLOWING WATER AND BED SEDIMENT. Kudo, Akira. Austin, Tex.; Univ. of Texas (1969). 168p.

Thesis.

The delay in transport of radionuclides caused by the interaction between flowing water and bed sediments was determined. This interaction phenomenon for cesium-137 was observed by using a set of flumes, each 50 feet in length and a model river which was 200 feet long. The greatest uptake rate, Kst, by bed sediment was 88.7×10^{-4} [(cpm/cm^2)/(cpm/cm^3)]/(sec) with a velocity of 1.65 fps and a flow rate of 0.345 cfs/ft. In this case the sediment transport rate was 0.0795 lbs/sec-ft. A mathematical model was developed describing the migration of radionuclides into the sediments. The relative concentration of radionuclides on the surface of the bottom sediments to that in the bed sediment was found to be a function of $z/(2\sqrt{Dt})$, where z, D, and t respectively, are the depth of bed sediment from the surface, diffusion coefficient of cesium-137 in water, and time after migration started. (Diss. Abstr.)

9520 RADIOCARBON DATING. Libby, W. F. (Univ. of California, Los Angeles). Chem. Brit.; 5: 548-52(Dec 1969).

A review is given of radiocarbon dating, including early experimental work and new potentials. (UK)

9521 A STUDY ON ^{220}Rn EMANATION FROM SOILS. Guedalia, Daniel; Laurent, Jean-Louis; Fontan, Jacques; Blanc, Daniel; Druilhet, Aime (Faculte des Sciences, Toulouse). J. Geophys. Res.; 75: 357-69(10 Jan 1970).

A measurement method of ^{220}Rn soil emanation is presented. Some measurements were made by means of an experimental model in the laboratory in order to determine the influence of certain parameters on the emanation rate. The seasonal and daily variations of the ^{220}Rn flux were also studied. It is shown that the seasonal variations are related to soil moisture variations, whereas some daily variations are due to the temperature difference between the air and the soil. (auth)

9522 PROSPECTS OF USING Ac–Be AND Po–B NEUTRON SOURCES IN LOGGING AND EXPLORATION GEOPHYSICS. Blankov, E. B.; Kaipov, R. L.; Leipunskaya, D. I.; Paklinov, V. A.; Savosin, S. I.; Spiridonov, V. P.; Fedorov, V. V.; Shestakov, L. I.; Shimelevich; Yu. S. Tr., Vses. Nauch.-Issled. Inst. Yadern. Geofiz. Geokhim.; No. 1, 197-205(1968). (In Russian).

Tests show that Ac-Be isotopic sources can be used instead of Po-B sources in neutron logging; the high gamma background of Ac-Be sources can easily be reduced by absorbing filters. The advantage of Ac-Be sources is their long service (half life 21.7 years). They can be used in wells of any diameter, including wells with flowing pipes. It is also shown how in aluminum silicate rocks, activation logging with a Po-B source makes it possible to determine the alumina content in the rocks regardless of the presence of silica, and with successive irradiation by Po-B and Ac-Be sources, to determine silica and alumina separately. (Geophys. Abstr.)

9523 DEVELOPMENT OF THE APPARATUS AND PROCEDURE OF OXYGEN LOGGING. Popov, N. V.; Gorbunov, V. F. Tr., Vses. Nauch.-Issled. Inst. Yadern. Geofiz. Geokhim.; No. 1, 192-7(1968). (In Russian).

Determination of the position of the water–oil interface in formations saturated with freshwater should be very important in well logging by the oxygen activation method; the difference in oxygen concentrations in the oil-bearing and water-bearing parts of a formation depends on its porosity, and when porosity is 20% in both the oil-saturated and water-saturated portion, the difference may be 15 to 17%. A pulsed method of recording induced radioactivity has been developed, based on the use of pulsed neutron generators. The principle, apparatus, and procedure of pulsed oxygen logging are described briefly. Tests have demonstrated the feasibility of the method. (Geophys. Abstr.)

Meteorology

Refer also to abstracts 9252, 9422–9426, 9544, 9709, 9712, 9795, and 9807.

9524 (A-AC–82/G/L-1307) SOME FALLOUT PATTERNS OF NUCLEAR EXPLOSION PRODUCTS IN THE ARMENIAN SSR. Atanesyan, S. G. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow). 1968. 18p. (In Russian). Dep. CFSTI (U. S. Sales Only).

Armenia is located at an average of 1800 m above sea level between latitudes 31 and 41°N, i.e., in the zone, in which increased fallout has been observed. On the basis of more than 2000 fallout, soil and air samplings involving the determination of ^{90}Sr and ^{137}Cs in the samples, certain laws controlling the fallout of nuclear explosion products in this region were derived. It was noted that the precipitation was more than twice higher in the mountain regions than in the Ararat plains. A direct correlation was found to exist between the amount of the fallout and the number of rainy days per year; up to 60% of the annual fallout was found to pre-

cipitate during the second quarter of the year. In the dry Ararat plains, the ^{90}Sr and ^{137}Cs content of the fallout was close to that observed in the central region of the European USSR; this was attributed to the coincidence of the springtime shift of the tropopause and the maximum fallout periods. While the soil contamination by ^{90}Sr could be closely correlated to the fallout in the plains region, this was not the case in the mountainous areas. (TTT)

9525 (COO-1199-18) STUDY OF RAINOUT OF RADIOACTIVITY IN ILLINOIS. Progress Report No. 8. (Illinois State Water Survey, Urbana). Nov 1969. Contract AT(11-1)-1199. 49p. Dep. CFSTI.

Research during 1969 on washout and rainout of radioactive debris is summarized. On May 29, indium flares were ignited on an aircraft in the vicinity of a thunderstorm. The collection of rainout and dry fallout samples to determine the areal and temporal variability of certain trace metals was partially carried out, but due to errors the experimental results are not complete. Experiments were conducted in the laboratory to study the removal of radioactive material from the atmosphere to determine the physical processes responsible for scavenging the material both within and beneath the cloud. Bacillus subtilis spores were used in the scavenging studies in the laboratory. Results showed that particles greater than 1 μ dia were efficiently scavenged. (J.C.W.)

9526 (NYO-4061-1) [MEASUREMENT OF AIRBORNE AND PRECIPITATION RADIOACTIVITY AND METEOROLOGICAL APPLICATION]. Progress Report No. 1. (Fraunhofner-Gesellschaft, Garmisch-Partenkirchen (West Germany). Physikalisch-Bioklimatische Forschungsstelle). 18 Nov 1969. Contract AT-(30-1)-4061. 24p. Dep. CFSTI.

The meteorological significance of radioactivity in the atmosphere was studied. Literature on mass exchange in the atmosphere and world-wide transport of radioactive fallout was reviewed. Equipment was selected and installed for measuring fallout deposition and radioactivity and for identifying the ^{7}Be and ^{32}P content in the air. Initial data taken during Nov. 1969 is presented. (L.C.L.)

9527 (SC-DC-69-2102) FALLING SPHERE AS AN ATMOSPHERIC MEASUREMENT TECHNIQUE. Smith, Lawrence B. (Sandia Labs., Albuquerque, N. Mex.). 9 Dec 1969. 29p. Dep. CFSTI.

The equipment and methods in the falling sphere program for measuring atmospheric temperatures and densities at altitudes from 30 to 110 km and winds at altitudes from 30 to 70 km are described. The 66 cm dia non-instrumented spheres made of radar reflective Mylar were rocket launched to the desired altitude, ejected from the rocket, automatically inflated with isopentane, and radar tracked throughout their descent. The method used to compute atmospheric density from radar measurements of the acceleration and velocity of the falling sphere is described. The computed densities were, in turn, used in the perfect gas equation to calculate the atmospheric temperature. Of the 30 experiments conducted with falling spheres between 1964 and 1969, 21 were successful for obtaining density, temperature, and wind data. The density and temperature results were compared with 1962 standards, and were similar for altitudes up to 75 km. It was concluded that the falling sphere technique is a reliable and economical method of observing the neutral atmosphere up to approximately 100 km. (L.C.L.)

9528 (UCRL-Trans-10412) WASHOUT OF RADIOACTIVE ISOTOPES INJECTED ARTIFICIALLY INTO A CLOUD, ACCORDING TO GROUND-STATION OBSERVATIONAL DATA. Shopauskas, K. K.; Styro, B. I.; Vebra, E. Yu.; Vebrene, B. K.; Shalaveyus, S. S.; Shopauskene, D. A. Translated by A. M. A. Mincer for Lawrence Radiation Lab., Livermore, Calif., from pp 323-33 of Issledovanie Protsessov Samoochishcheniya Atmosfery ot Radioaktivnykh Izotopov. Palanga, Lithuanian SSR, July 7-9, 1966. 15p. Dep. CFSTI.

The mechanism of washout of radioactive isotopes by precipitation after artificial contamination of individual parts of clouds with such isotopes was studied. Two isotopes, ^{32}P in the form of powdered chromium phosphate and ^{210}Po in the form of polonium nitrate, were mixed in ethanol. The mixtures were placed in hollow heads of anti-hail rockets, fired into a cloud, and sprayed out by a destructor mechanism. Four rocket injections of ^{210}Po and seven injections of ^{32}P were made into rain clouds. The rain samples were collected, evaporated, and the activities of the dry residues measured. The distribution of the amount of precipitation and the distributions of the ^{32}P and ^{210}Po were determined and plotted. The distances from the injection point to points of highest concentrations and fallout densities and the time lapse between cloud injection and detection of the radioisotopes in raindrops were determined. However, no correlation between activity concentration, or the fallout density and the amount of precipitation could be found. (L.C.L.)

9529 INTER-HEMISPHERIC TRANSFER OF FRESH DEBRIS FROM FRENCH NUCLEAR TESTS IN 1968. Sotobayaski, T.; Suzuki, T.; Furusawe, A. (Univ. of Niigata, Japan). Nature (London); 224: 1096-7(13 Dec 1969).

An investigation was made of the inter-hemispheric transfer of airborne material by measuring the activities in rainwater in Japan of short-lived fission products resulting from the 1968 French nuclear tests in the S Pacific, and the results are shown in tabular form. Rain samples collected on Aug. 5th, 12th, and 21st consisted chiefly of long-lived stratospheric nuclides ($^{95}Zr-^{95}Nb$, $^{106}Ru-^{106}Rh$, ^{137}Cs and ^{144}Ce) resulting from the Chinese nuclear explosions on June 17th and Dec. 28th, 1967 and earlier nuclear events; no short-lived fission products such as ^{131}I and ^{140}Ba were detected. The findings suggested that there was no fresh nuclear debris in the upper atmosphere over Niigata by mid-August. Some ^{140}Ba, however, was found in a rain sample on Aug. 24 to 26th, suggesting that fresh nuclear clouds arrived over Japan and were washed out in rain during late August. One of the underground tests conducted by the USA or Soviet Union could have been the cause, but such a cause had to be discarded, and it seems more probable that the cause was the French series of atomic and hydrogen bomb explosions in the S Pacific in July, August, and September. The estimated time for this fresh airborne debris to reach Niigata from the French testing ground was estimated to be 46 ± 3 days, with an average speed of 12 km/hr, a value comparable with the mean speed of typhoons which visited Japan between August and September. (UK)

9530 ATMOSPHERIC TRITIUM AS AN INDICATOR OF AIR MASSES. Yoneda, Kazuo; Kigoshi, Kunihiko (Gakushuin Univ., Tokyo). Geochemistry (Nagoya); 2: No. 1, 1-7(1968). (In Japanese).

The variation in tritium concentration in atmospheric moisture was measured in Tokyo in May 1966 and July 1968. Detailed experimental procedures and a discussion on the correlation between the variation in tritium concentration and the nature of air masses are presented. The observed results showed fairly good correlation between weather development and tritium concentration. Tritium concentration in moisture was high, when the continental air mass was located above Tokyo, and low, when the oceanic air mass was located. This method is available to analysis of air mass. (auth) (NSA of Japan)

9531 RADIOACTIVE FALLOUT MONITORING IN ITALY. Com. Naz. Energ. Nucl., Notiz.; 15: 95-7(Nov 1969). (In Italian).

A report is given on the Italian system for the monitoring of radioactive fallout. (auth)

Mineralogy and Exploration

9532 URANIUM, THORIUM, AND POTASSIUM CONTENT OF KUMOTANIYAMA AND MIHAMA GRANITIC BODIES. Katsura, Kyozo (Kyoto Univ.); Nishimura, Susumu. Ganseki Kobutsu Kosho Gakkaishi; 62: No. 1, 50-3(Jul 1969). (In Japanese).

The distribution of uranium, thorium, and potassium content in granitic bodies was determined. The results indicated that uranium and thorium concentrate toward the periphery of the intrusive mass. The contents of the granites was: Kumotani granitic bodies, 3.3 ppM U; 10.4 ppM Th; and 2.6% K: Mihama granite, 4.4 ppM U; 11.6 ppM Th; and 3.0% K. (auth)(NSA of Japan)

9533 PHYSICAL AND CHEMICAL CONDITIONS OF URANIUM UNDERGROUND LEACHING FROM ROCKY ORES. Lutsenko, I. K.; Bakharov, V. G.; Meshcherskaya, R. S. At. Energ. (USSR); 27: 500-4(Dec 1969). (In Russian).

The dynamics of solution movement into ores and uranium extraction along its section are described. The mechanism and kinetics of uranium capillary leaching from uranium minerals and some grained ores by chemical reagents were considered. The change of ore chemical composition and physical-mechanical properties at the underground leaching were investigated. On the basis of experimental data, equations describing the process kinetics were composed. The limits and perspective application of uranium underground leaching from poor ore are defined. (auth)

9534 MINERALIZATION, ALTERATION, AND MECHANISM OF EMPLACEMENT, ORPHAN ORE DEPOSIT, GRAND CANYON,

ARIZONA. Gornitz, Vivien Monisa. New York; Columbia Univ. (1969). 196p.
Thesis.

The Orphan Mine uranium orebody occurred in a nearly circular, vertical pipe structure, about 350 feet in diameter, which penetrated Permian strata in the Grand Canyon, Arizona. A shear zone paralleled the pipe contact, where explored. The pipe fill consisted of massive quartz sandstone derived from the Coconino Sandstone and angular to subrounded breccia blocks of siltstones and shales from the Supai and Hermit Formations. The pipe fill was correlated with samples of stratigraphic units taken along the canyon trails. The pipe may have extended upward to the Toroweap and Kaibab Formations, but evidence to that effect is lacking because of erosion. No breccia blocks were elevated from below the Supai, nor was there any volcanic or extrusive material within the pipe, thus ruling out an explosive volcanic origin. The pipe most probably formed by solution collapse into the underlying Redwall Limestone. Uranium ore was concentrated along the pipe margins and also within the pipe. Primary metallic minerals included uraninite, chalcopyrite, bornite, chalcocite, tennantite, pyrite, and lesser amounts of sphalerite, galena, and rammelsbergite. The minerals were zoned as follows: pyrite and uraninite in the center of the pipe grading into copper sulfides, galena and uraninite at the margins. Elements such as Mo, Co, Ni, As, Mn, and V were present in trace amounts; Th and the rare earth group were not detected. Effects of alteration included bleaching of normally red Supai sandstone near the contact and within the pipe, carbonatization and development of hematitic haloes around uraninite. No silicification or argillic alteration were found. Temperatures of formation determined by fluid inclusion thermometry of calcite ranged from 60 to 110°C. The estimated minimum temperature from burial of the sediments and the geothermal gradients was 58 ± 5°C. U/Pb ages of about 140 million years show that the uranium is much younger than the enclosing rocks (Permian–260 million years). Sulfur isotope ratios were enriched in ^{32}S over ^{34}S. Although the pipe structure, ore distribution and mineralogy suggested an origin from ascending hydrothermal solutions, the lack of a nearby igneous source of appropriate age, apparent low temperature conditions and sulfur isotopes enriched in ^{32}S, which imply bacterial reduction of sulfate, would make a direct magmatic hydrothermal origin unlikely. The ore solutions may have been derived from a distant hydrothermal source, and then have mingled with ground water. (Diss. Abstr.)

Oceanography

Refer also to abstracts 9696 and 9709.

9535 (NVO–289–5) OSCILLATIONS OF HARBOR OF ARBITRARY SHAPE AND VARIABLE DEPTH AND AMCHITKA FIELD EXPERIMENTS. Final Report. Hwang, Li-San; Butler, H. Lee; Divoky, David; Le Mehaute, Bernard (Tetra Tech, Inc., Pasadena, Calif.). Nov 1969. Contract AT(26–1)–289. 212p. (TC–148). Dep. CFSTI.

Both the experimental and theoretical work performed to predict the effects of nuclear explosion-induced water waves on harbors of Amchitka Island, Alaska, are described. A mathematical analysis was made of wave agitation in a harbor of arbitrary shape and variable depth. Wave tank experiments were performed to investigate the runup and wave height of breaking waves in a 3-dimensional bay. Wave generation by bottom motion and turbidity currents anticipated from the explosions are discussed. Three appendices are included; two present computer programs written for this study and the third discusses the relative merits of scale model studies and computer analyses in the problem of harbor design. (L.C.L.)

Seismology

9536 COMPARISON OF THE 1968 P TABLES WITH TIMES FROM NUCLEAR EXPLOSIONS. I. LONGSHOT AND GREELEY. Cleary, J. R.; Muirhead, K. J. (Australian National Univ., Canberra). Earth Planet. Sci. Lett.; 7: 119–24(Nov 1969).

The chief differences between recent determinations of the P travel time curve beyond about 24° may be expressed, in each case, as a deviation in the slope of the curve which is approximately constant throughout the range. If one of these curves is used to calculate the residuals of P times from a seismic event, with station corrections applied, then it is possible to solve simultaneously for the value of this deviation and for the source correction. This has been done for the nuclear explosions Longshot and Greeley, using the 1968 P tables and the Herrin–Taggart station corrections. In both cases the calculated deviation was close to that of the Cleary–Hales curve. The analysis of the Longshot data was repeated using the times and station corrections derived by Lilwall and Douglas, and essentially the same result was obtained. (auth)

9537 COMPARISON OF THE 1968 P TABLES WITH TIMES FROM NUCLEAR EXPLOSIONS. II. THE MARSHALL ISLANDS AND SAHARA SERIES. Muirhead, K. J.; Cleary, J. R. (Australian National Univ., Canberra). Earth Planet. Sci. Lett.; 7: 132–6(Nov 1969).

P times from Longshot and Greeley have recently been analyzed by Cleary and Muirhead, using 1968 P times and Herrin–Taggart station corrections to derive source corrections and travel time corrections (the latter being assumed to vary linearly with distance). The analysis is here extended to times from the series of nuclear explosions in the Marshall Islands and in the Sahara. Combination of the results for the four explosion sites results in a value of -0.023 ± 0.004 sec/deg for the slope of the line representing the error in the 1968 P curve. By comparison, the mean slope of the Cleary–Hales deviation curve is -0.022 sec/deg. The effect of the error in the slope of the 1968 P curve would be overestimate focal depths of seismic events by about 70 km. (auth)

9538 SEISMIC STUDIES EFFECTED FOR THE UNDERGROUND FRENCH NUCLEAR EXPLOSIONS. Duclaux, Francoise; Albaret, Agnes; Ferrieux, Henri; Perrier, Michel (CEA, Paris). Ann. Geophys.; 25: 681–92(Jul–Aug–Sep 1969). (In French).

The direct seismic effect of underground nuclear explosions can be characterized by averaging the deconvoluted signals after a precise calibration of the seismic recording instruments. The signals obtained at a depth of 42m are much more coherent than those obtained on the surface. Some results concerning amplitudes and spectra of seismic waves as well are given. Secondary phenomena following the detonation provide a relation between the time of formation of the chimney and the final radius of the cavity; the study shows the diversity of the phenomena. Finally a seismic method for probing the mountain mass reveals three concentric zones affected by the explosion; one of them corresponding with some geological observations. (auth)

9539 PROJECT STERLING: SUBSURFACE PHENOMENOLOGY MEASUREMENTS NEAR A DECOUPLED NUCLEAR EVENT. Sisemore, Clyde J. (Univ. of California, Livermore); Rogers, Leo A.; Perret, William R. J. Geophys. Res.; 74: 6623–37 (15 Dec 1969).

The purpose of the Sterling event, a 380-ton nuclear explosion detonated in a spherical cavity, was to test the decoupling theory for nuclear explosives detonated in explosively generated cavities. Measurements of stress history, cavity pressure, and cavity collapse were attempted in the very close-in region between 17 and 52 meters from the cavity center; free-field measurements of particle velocity and acceleration were made in the immediate region between 52 and 660 meters as measured from the cavity center. Peak accelerations measured over this interval ranged from 150 to 0.2 g; peak velocities ranged from 0.13 to 0.01 m/sec. The assumption of cube-root scaling was used in the analysis of the reduced displacement potentials and their Fourier transforms to obtain a free-field decoupling ratio of about 100 for a frequency range near 10 Hz. Above 10 Hz, the decoupling ratio drops rapidly to about 20. These results are in reasonably good agreement with the decoupling theory. (auth)

9540 DISCUSSION OF PAPER BY D. SPRINGER, M. DENNY, J. HEALY, AND W. MICKEY, "THE STERLING EXPERIMENT: DECOUPLING OF SEISMIC WAVES BY A SHOT-GENERATED CAVITY". Murphy, John R. (Environmental Research Corp., Alexandria, Va.). J. Geophys. Res.; 74: 6714–18(15 Dec 1969).

Additional theoretical analyses verified with data obtained over a wider frequency band than that presented previously (Springer et al, J. Geophys. Res., 73: 5995 (1968)) on the Sterling nuclear decoupling experiment are presented. The seismic instruments used to record the events Salmon and Sterling are characterized by low-frequency rolloffs. Using an analog correction circuit and an analog computer, the resulting effective instrument response gives reliable information down to 0.3 Hz. The circuit was employed in processing Salmon and Sterling measurements to obtain data over the frequency range of 0.3 to 100 Hz. Data indicate that the decoupling at low frequencies is less than that indicated by data in the vicinity of 1 Hz, hence an analysis was performed that satisfactorily explains the observed frequency dependence in terms of a simple analytic expression. (J.C.W.)

ENGINEERING

Nuclear Explosions

Refer also to abstracts 9492, 9501, 9503, 9515, 9535–9540, and 9840.

9541 (HN-20-213) COMPUTER SIMULATION OF NUCLEAR OPERATIONS FOR THE SEA LEVEL CANAL. Baldonado, O. C.; Perla, H. F. (Holmes and Narver, Inc., Los Angeles, Calif.). Nov 1969. 96p. Dep. CFSTI.

Computer simulation techniques using the General Purpose Simulation System (GPSS/360) were used to simulate nuclear detonations programs for the Interoceanic Canal project whereby the effects of several firing constraints on the schedule were investigated. One constraint investigated was the effect of different weather restriction categories due to air blast and fallout. The effect of increasing the number of emplacement and stemming crews also was investigated. The effect of varying the reentry period after detonating a row charge, or salvo, was assessed. Detonation programs were simulated for proposed Route 17A and Route 25E. The study demonstrated the method for using computer simulation so that a schedule and its associated constraints can be assessed for feasibility. Since many simulation runs can be made for a given set of detonation program constraints, it is possible to readily obtain an average schedule over a range of conditions. The weather is randomly sampled based on the expected probability that one can detonate a salvo on any given day of the year. Each salvo has a specific category for air blast and fallout restrictions. During each simulation, the time for which a given event occurs (e.g., the detonation of a salvo or set of salvos) is printed out and averaged out after ten simulation trials. Thus, a methodology is established to analyze the time-sensitive operations so that time and cost effective operational schedules can be established. The methodology can be applied to other operations where weather, number of crews, or other variables affect the schedule. (auth)

9542 (HN-20-1028) STRUCTURAL RESPONSE TO CLOSE-IN VERTICAL GROUND MOTION FROM UNDERGROUND NUCLEAR TESTS AT PAHUTE MESA. VOL. 1. SINGLE DEGREE OF FREEDOM ELASTIC STRUCTURES. Kennedy, R. P. (Holmes and Narver, Inc., Las Vegas, Nev. On-Continent Test Div.). Jul 1969. Contract AT(29-2)-20. 212p. Dep. CFSTI.

An investigation was made of the response of a single degree of freedom elastic structure to the vertical component of the ground motion resulting from three intermediate yield events (Halfbeak, Scotch, and Greeley) at horizontal distances ranging from surface zero to more than two times the shot depth for the event. Information for each of the recorded ground motions include structural response spectra as a function of damping, a comparison of response spectra generated from ground velocity time history records with those from ground acceleration time history records, a procedure which enables the engineer to generate response spectra envelopes when given certain peak parameter information concerning the ground motion, a comparison of structural response from a generated simple acceleration time history with response from actual records, and plots of structural response time histories at representative structure frequencies. Structure frequencies ranging from 0.5 to 45 cps are considered. (J.C.W.)

9543 (NCG-TR-14) NATURAL RUBBLE SLOPES AND THEIR RELEVANCE TO CRATER FALLBACK SLOPES. Lutton, R. J. (Army Engineer Waterways Experiment Station, Vicksburg, Miss.). Sep 1969. 189p. Dep. CFSTI.

Natural rock rubble deposits offer useful information on characteristics and behavior of crater fallback if their geomorphic histories are recognized and understood. The characteristics of seven slope deposits were considered: talus, colluvial mantle, alluvium, mudflow debris, rock glaciers, moraine, and modified debris. Of these, talus is most similar to fallback. Talus slopes range to 1,600 feet or greater in height and appear to average about 34, 33, 31, 31 and 24 degrees in semiarid, alpine, subarctic, temperate, and tropical climates, respectively. Mixing of materials by a cratering event should tend to make fallback slightly more stable than corresponding natural rubble. Fallback is out of equilibrium with its environment, particularly the manifestations of climate, and may undergo major erosional and weathering modifications. The long-range result of these modifications, however, is a more stable configuration. (auth)

9544 (UCRL-50631) PALANQUIN EVENT: QUANTITATIVE POSTSHOT DISTRIBUTION OF CLOSE-IN FALLOUT, THROWOUT, AND BASE SURGE. de Lalla, Oliver F. (California Univ., Livermore. Lawrence Radiation Lab.). 5 Aug 1969. 21p. Dep. CFSTI.

Mass concentration data derived from fallout trays placed in and around the close-in environment of the Palanquin Event are presented and interpreted in terms of the mass distribution patterns. The objective was to obtain information relating to the mechanisms and relationships controlling the quantitative mass distribution of the debris in the close-in region. The results indicated that the mass distribution (grams of debris per square foot of land surface) for the Palanquin Event was characterized by several deposition rates depending on the distance from ground zero. The slope of distribution along the hot line from ground zero was very steep between ground zero and 3,000 ft, fell off less steeply but regularly between 3,000 and 15,000 ft, and appeared to become steeper again beyond 15,000 ft. Along the hot line between ground zero and 3,000 ft, the deposition rate fell by an order of magnitude within 2,500 ft. Beyond 3,000 ft, the same magnitude of decrease required 25,000 ft of distance. The rate of decrease laterally along perpendiculars from the hot line at fixed distances from ground zero was also considered. The deposition rate decreased much more rapidly with lateral distance from the hot line than with distance along the hot line from ground zero. At the 9,000 ft point on the hot line, it fell essentially to zero at about 5,000 ft from the hot line; at the 18,500 ft point, it fell to zero at 7,000 ft from the hot line. (auth)

9545 CANAL CONSTRUCTION IN CENTRAL AMERICA: A BIOLOGICAL CATASTROPHE? Vogt, Hans-Heinrich Naturwiss. Rundsch.; 22: 209-10(May 1969). (In German).

The feasibility of construction of sea-level canals in Central America by use of nuclear explosives was discussed briefly. In the past 25 yr 30 different possible routes have been suggested for canals in the area between the Isthmus of Tehuantepec and Colombia. Of these 5 appeared to be suitable for construction by use of nuclear explosives. These included Tehuantepec (Mexico), Nicaragua-Costa Rica, San Blas and Sasardi Morti in Panama, and Atrato-Truando in Colombia. The possible use of nuclear explosives raised the question of radioactive contamination of the atmosphere and the oceans, even though dilution effects soon would decrease the possibilities of acute contamination of the surrounding areas. The possibilities of serious biological effects from canal construction by nuclear explosives was discussed in general terms. (BBB)

9546 DETONATIVE PHASE TRANSFORMATIONS AND EARTHQUAKES. Ubbelohde, A. R. (Imperial Coll. of Science and Tech., London). Nature (London); 224: 895(29 Nov 1969).

It is stated that in detonation the liberated energy supports a shock front the impact of which on unreacted material induces progressive further energy release, and that hydrodynamic theory suggests it should be possible for a wide variety of physicochemical reactions to be propagated in this way at their characteristic detonation rates. In practice, however, detonation has been observed only for comparatively few such systems. The main reason for the rarity of detonations in physicochemical reactions is that unless the liberation of energy is very rapid most of it can be dissipated sideways, instead of contributing to the hydrodynamic propagation of the shock front, the impact of which triggers transformation in unreacted material ahead of it. When the dimensions of the reaction system become very large, however, such as on the geological scale, energy dissipation for even weak detonations becomes relatively much less important, and weak detonations are a definite possibility for large masses of reacting material. With the advent of seismic studies on underground nuclear explosions new testing possibilities become feasible. Secondary earthquakes resulting from nuclear explosions can be envisaged through the triggering of transformations at detonative rates in thermodynamically unstable phases present in large masses; or less probably by the action of the primary shock to cause transformation of large masses into an unstable solid state which relapses spontaneously as a secondary earthquake only after a lapse of time. Repeated underground nuclear explosions in the same area would eventually exhaust the first hypothesis, whereas the second could permit indefinite recurrence of secondary localized earthquakes wherever the geochemistry favored the necessary underlying physicochemical changes due to the primary shock wave. It is concluded that the possibilities of weak detonations on a geological scale should be kept in mind. (UK)

Facilities and Equipment

Refer also to abstracts 9450, 9507, 9650, 9710, 10021, 10023, 10447, 10459, 10485, 11120–11128, and 11279.

9547 (AGN-8191(Vol.8)) DEVELOPMENT OF APPARATUS TO MEASURE VISCOSITY OF GASES AND VAPORS. Alkali Metals Evaluation Program. Achener, P. Y. (Aerojet-General Corp., San Ramon, Calif. Nuclear Div.). Oct 1969. Contract AT(04-3)-368. 65p. Dep. CFSTI.

A vibrating wire viscometer has been developed to measure the viscosity of gases and vapors at high temperatures. The device measures the damping of the transverse vibrations of a taut wire in the sample fluid. An absolute determination of viscosity is obtained from decay time and frequency data, eliminating the hydrodynamic corrections and apparatus calibrations required by the commonly used methods. The major components are a short length of tungsten-rhenium wire rigidly supported in tension within a strong electromagnetic field; an electromagnet; and readout instrumentation. A dc signal sets the wire in motion after which a fast-acting switch immediately disconnects the dc supply and connects the wire to an oscillograph. The wire, oscillating in the magnetic field, produces a voltage signal which is amplified and recorded on the oscillograph chart. Decay time is determined from the oscillograph trace. The oscillation frequency is measured simultaneously with an Eput meter. A prototype wire viscometer has been constructed and operated with air and argon over the temperature range from 18 to 200°C. Results agree within 1% of accepted literature values. Another apparatus, fabricated from refractory metal alloy, was operated with alkali metal vapors at high temperatures. However, due to mechanical difficulties with this apparatus, experimental data on alkali metal vapors could not be obtained. (auth)

9548 (BNWL-1200-1, pp 5.1-13) ENGINEERING SUPPORT FUNCTIONS. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Design of a prototype applications loop was initiated. The system is to provide a testing and development sodium system for sodium chemical technology research. Information is included on trace heaters for the loop and power controllers for the heaters. Design of an in-line double bellows valve for cover gases and vacuum control in the loop is also reported. (J.R.D.)

9549 (GA-9342) A REVIEW OF DESIGN CRITERIA FOR THE STEAM GENERATOR OF THE 330-MW(e) HIGH TEMPERATURE GAS-COOLED REACTOR PLANT OF THE PUBLIC SERVICE COMPANY OF COLORADO. Schuetzenduebel, W. G.; Hunt, P. S. (Gulf General Atomic, Inc., San Diego, Calif.). 15 May 1969. Contract AT(04-3)-633. 42p. (CONF-691114-1). Dep. CFSTI.

From 90th Annual Meeting on American Society of Mechanical Engineers, Los Angeles, Calif.

The various design criteria are reviewed for the steam generator for a high temperature gas-cooled reactor (HTGR) plant to be constructed and operated by the Public Service Company of Colorado (PSC). The plant, known as the Fort St. Vrain Station, is located about four miles northwest of Platteville, Colorado. The plant has two parallel steam-generator loops, each loop containing six individual steam-generator modules. Nominal operating conditions and upset or emergency conditions that govern the design of the steam generator in general, and certain steam-generator components in particular, are discussed. Compliance with all applicable ASME code sections is reviewed for critical components covered by the code. Compliance with codes other than ASME is reviewed for parts classified as non-ASME code parts. Certain steam-generator components and certain structural members, which do not fall under the jurisdiction of the ASME code or other codes, are mentioned in relation to how the ASME code, Section III, was used as a guide in the analysis. Also discussed are other criteria, which are not related to the structural analysis but do have a definite effect on the structural integrity of the steam-generator components. (auth)

9550 (NVO-374-16) HAWAII DEVELOPMENT IRRADIATOR PROGRAM. Annual Report, July 1, 1967-June 30, 1968. Dollar, Alexander M.; Hanaoka, Masao; McClish, Gale A. (Hawaii State Dept. of Agriculture). Aug 1968. Contract AT(26-1)-374. 301p. Dep. CFSTI.

The Hawaii Development Irradiator, completed in 1967 as a prototype of commercial facilities for the irradiation of tropical fruits and grains in order to achieve extended shelf-life and effective disinfestation, is described in detail as to design, operation, maintenance, cost, and effectiveness. By July 1968, the unit had been used to irradiate 185,000 lb of commodities including mangos, papayas, potatoes, and wheat flour. The acquisition and analysis of dosimetry data are discussed. Methods for producing, packaging, irradiating, shipping, storing, and marketing papayas are described. Several appendices which analyze data on these operations are presented. (L.C.L.)

9551 (ORNL-HUD-2) URBAN NUCLEAR ENERGY CENTER STUDY: ESTIMATES OF PROCESS STEAM CONSUMPTION BY MANUFACTURING INDUSTRIES IN THE UNITED STATES FOR THE YEAR 1980. Miles, F. W. (Oak Ridge National Lab., Tenn.). Jan 1970. Contract W-7405-eng-26. 19p. Dep. CFSTI.

Estimates were made of the consumption of process steam by manufacturing industries in the United States for the year 1980 as part of a program for evaluating the usefulness of urban nuclear energy centers. Perazich-type assumptions were made with respect to the use of steam by the selected industries. Steam consumption in 1962 was estimated by several methods for selected industries from fuel consumption data in the Census of Manufactures. The values were projected to 1980 by using energy consumption projections of the type made by the Texas Eastern Transmission Corporation. The estimates of steam consumption for 1980 varied from 67.6×10^{14} to 95.4×10^{14} Btu depending on the methods and assumptions employed. This estimated consumption of steam by manufacturing industries is approximately equal to the 92×10^{14} Btu of electrical energy estimated to be required in 1980. This indicated that a significant amount of thermal energy from an urban nuclear energy center would be consumed by manufacturing industries if the area served by the center had a fraction of the country's population. (auth)

9552 (RISO-M-987) MOBILE GAMMA THERAPY UNIT FOR EXTRACORPOREAL IRRADIATION OF BLOOD: ECIB-II. Rasmussen, Ingv. (Danish Atomic Energy Commission, Risoe. Research Establishment). Nov 1969. 16p. Dep. CFSTI (U. S. Sales Only).

A compact, mobile γ-irradiator was developed for extracorporeal irradiation of blood. The unit is based upon a ^{137}Cs source and can be used in unrestricted areas. The transit dose is continuously variable between zero and a maximum of 700 rads, corresponding to a 100 ml/min blood flow. A presentation is given of the irradiator design, the radiological safety aspects and the operation procedures. (auth)

9553 HEAT EXCHANGER ELEMENT POSITIONING. (to Societe Fives Lille-Cail). British Patent 1,175,636. 23 Dec 1969. Priority date 8 Aug 1967, France.

A design is given of equipment for placing in position and dismantling the elements of heat exchangers used in nuclear power stations for generating the steam supplied to a thermal power station from the heat produced in the reactor. (J.C.W.)

9554 ON-LAND FACILITIES FOR THE FIRST NUCLEAR-POWERED SHIP. Sumitomo Kikai Giho; 17: 440-2(Jun 1969). (In Japanese).

The site for the on-land facilities for the first nuclear-powered ship has been selected at Mutsu City, Aomori Prefecture. The on-land facilities are for equipping the nuclear-powered ship with a reactor plant, exchanging fuel for the ship, receiving and storing fresh fuel, storing and shipping spent fuel, unloading radioactive wastes from the ship, treating and disposing of the radioactive wastes from the ship and the land facilities, and maintenance and repair of the ship. The facilities include buildings for fuel exchange, power supply, radiation control, radioactive waste disposal, administration, and a pier. The on-land facilities described include storage of spent fuel, storage of fresh fuel, decontamination, maintenance and repair of the ship, radiation control, treatment and disposal of radioactive wastes, cranes at the pier, and power supplies. (NSA of Japan)

9555 A NON-LINEAR ANALYSIS OF THE ROTATIONAL STIFFNESS OF A NUCLEAR STEAM GENERATOR FOUNDATION. Yang, Henry T. Y.; Godfrey, D. A. (Gilbert Associates, Inc., Reading, Pa.). Nucl. Eng. Design; 10: 339-48(Jul 1969).

A non-linear analysis of the moment-rotation relationships of a circular foundation for equipment of a nuclear steam supply system is presented. Equations are derived and numerical results given for normal mild steel anchor bolts and circular base plate arrangement and post-tensioned high-strength steel anchor bolts and circular base plate arrangement. An axisymmetric finite element computer program was applied for finding the stiffness of concrete in compression. The inelastic behavior of steel bolts is accounted for by an iterative procedure. (auth)

9556 OUTLINE OF THE MAIN TURBINE MACHINERY FOR THE FIRST NUCLEAR-POWERED SHIP. Genshiryokusen; No. 68, 1689-1703(Jun 1969). (In Japanese).

Construction of the first nuclear-powered ship was started in November 1968, in Ishikawajima-Harima Heavy Industries Co., requested by JNSDA; its launching is expected in June 1969. The main turbine machinery for the ship was completed in March 1969, and its land test was also finished; it will be installed in the ship in May. The turbine machinery, consisting of the tur-

bine, reduction gear, and condenser, has the following features: type, cross-compound and impulse with two-step reduction; steam pressure at the high-pressure turbine inlet, 39.5 and 37.5 kg/cm^2 G at normal and continuous-maximum outputs, respectively; steam dryness at the same point, both 99.3%; evacuation in the condenser upper-part, 722 and 720 mm Hg, respectively; normal, continuous-maximum, and continuous-back astern shaft output, 9000 PS × about 193 R/M, 10,000 PS × 200 R/M, and about 3400 PS × 135 R/M, respectively. Descriptions of the main turbine machinery for the first nuclear-powered ship include: features of the machinery; turbine (high-pressure turbine, moisture separator, low-pressure turbine, packing-steam and drain system, and overspeed prevention); reduction gear; steam condenser; and remote operation. (NSA of Japan)

9557 AUTOMATIC INSPECTION OF FUEL ELEMENT PELLETS. Metrol. Insp.; 1: 50-2(1969).

A high rate ceramic fuel pellet inspection machine is described. It employs electronic and pneumatic devices to inspect seven dimensional features of each pellet at a rate of 1,800 pellets per hour. Accuracy of the pellet dimensions and the absence of excessive depressions at the surface or corners are checked. (UK)

9558 IMPROVEMENTS IN WELDING METHODS. (to Gesellschaft fuer Kernforschung mbH). British Patent 1,172,040. 26 Nov 1969. Priority date 30 Dec 1966, Germany.

A method is described for making a weld connection between a tube and a generally cylindrical end-plug which is partly inserted in the tube. The welding method is applicable to a reactor fuel element tube and closure plug. (J.C.W.)

9559 STEAM GENERATOR AND SEPARATOR. (to Aktiebolaget Atomenergi). British Patent 1,177,102. 7 Jan 1970. Priority date 31 Mar 1966, Sweden.

A design is given for a steam generator and separator which receive hot pressurized water from a nuclear reactor, generate steam from the water, and return the water to the reactor without the use of a pump. The design allows for operation at high efficiency and may be used with a water-cooled reactor which has high flow resistance to the cooling water. (J.C.W.)

9560 EVALUATION OF PRESTRESSED POST-TENSIONED FORCES ON THE SHALLOW DOME OF CONTAINMENT STRUCTURES. Godfrey, D. A. (Gilbert Associates, Inc., Reading, Pa.). Nucl. Eng. Design; 10: 325-38(Jul 1969).

The resultant radial, circumferential, and meridional pressures and anchorage forces of a three-layer tendon pattern for a shallow prestressed dome are presented. A constant horizontal or inplane tendon spacing is used in the analysis. The anchorage forces are given in terms of the X, Y, and Z coordinates of the containment vessel. Typical results of the variation of pressures and forces are presented. (auth)

9561 FLOW CONTROL VALVE. (to Gebr. Bohler and Co.). British Patent 1,170,993. 19 Nov 1969. Priority date 6 Apr 1966, Austria.

The design of a flow control valve is given with a casing incorporating a valve seat between the first and second pipe connectors for the fluid to be controlled. The pipe cross section at the valve seat is greater than at the connectors. A valve closure operates simultaneously with the valve seat to control the flow between the pipe connectors and spindle supporting the valve closure for axial movement. The spindle is surrounded by a bellows within the casing to seal the spindle from the fluid being controlled. The internal spaces of the bellows are heated electrically to eliminate freezing to ensure complete draining. (J.C.W.)

9562 TUBE SEALING VALVE. (to Canadian General Electric Co. Ltd.). British Patent 1,174,254. 17 Dec 1969. Priority date 20 Nov 1965, Canada.

A design is given of a tube sealing valve suitable for sealing the tubes of a bottom fueled vertical pressure tube nuclear reactor. The valve housing has an inlet and outlet opening for attachment to the tube. An annular valve seat surrounds the inlet opening and a rotary valve closure has a flow passage mounted in the housing for rotation about an axis at an angle to the axis of the flow passage. The valve design is combined with an adaptor to which a fueling machine can be locked during the refueling process. (J.C.W.)

9563 PROBLEMS ENCOUNTERED DURING THE CONSTRUCTION OF THE EUREX PLANT. Calleri, G.; Fiorelli, M.; Grassi, G. (Societa Ricerche Impianti Nucleari, Saluggia, Italy). Chem. Eng. Progr.; 65: Symp. Ser. No. 94, 33-52(1969).

From 60th Annual Meeting of the American Institute of Chemical Engineers, New York. See CONF-671103.

Originally designed for the reprocessing of MTR type of irradiated fuel, the Eurex plant was subsequently modified with a view to making possible pilot-scale research on the chemical procedures and on the equipment connected with the reprocessing of power-reactor fuels. The construction of the plant, now in an advanced stage, was started in January, 1966. Cold tests are expected to begin during the first months of 1968. The compactness of the plant and the construction specifications have raised, and are still raising, considerable technical and organizational problems, both for the suppliers of materials (plates, tubes, etc.) and for the construction of civil works, facilities, and equipment. After a brief description of the plant, an account is given of the basic criteria used in the construction, the greatest difficulties encountered, and the main solutions adopted. (auth)

9564 CONSTRUCTION AND OPERATION OF THE WEST VALLEY REPROCESSING PLANT. Runion, T. C.; Lewis, W. H. (Nuclear Fuel Services, Inc., West Valley, N. Y.). Chem. Eng. Progr.; 65: Symp. Ser. No. 94, 53-60(1969).

From 60th Annual Meeting of the American Institute of Chemical Engineers, New York. See CONF-671103.

The first commercial reprocessing plant for spent nuclear fuel began operation at West Valley, New York, in April 1966. Since then, more than 200 tons of fuel have been processed. While some start-up problems have been encountered, operation has been generally quite successful. The plant and process are briefly described. The capital cost of the plant, compared with its budgeted values, is shown. Operational data obtained during the first year and a half of operation are given. Some of the pitfalls and problems encountered during the start-up and early phases of the operation are discussed. (auth)

9565 OPERATION OF A PYROCHEMICAL PROCESSING-REMOTE REFABRICATION PLANT: THE EBR-II FUEL CYCLE FACILITY. Stevenson, C. E.; Feldman, M. J.; Hampson, D. C.; Paige, D. M.; Swanson, N. J. (Argonne National Lab., Idaho Falls, Idaho). Chem. Eng. Progr.; 65: Symp. Ser. No. 94, 61-9 (1969).

From 60th Annual Meeting of the American Institute of Chemical Engineers, New York. See CONF-671103.

For the past 3 yr, the Fuel Cycle Facility attached to Experimental Breeder Reactor-II has been reprocessing the sodium bonded, stainless steel jacketed, metallic fuel from the reactor by a simple melt refining process after decay cooling period as short as 12 days. The still highly radioactive recovered uranium-fission alloy is remotely recast and refabricated, and the completed fuel assemblies are returned directly to the reactor. Only the gaseous (krypton, xenon, iodine) and chemically active (cesium, strontium, barium, rare earth) fission products are removed in the process, while less active metals (molybdenum, ruthenium, palladium, rhodium, zirconium, niobium, technetium) remain in the fuel alloy. Much of the fuel has been processed three times; several hundred fuel assemblies have been processed, and many thousand individual fuel elements have been produced in this demonstration of the feasibility of operating a closed cycle including the reactor and the reprocessing and refabrication plants. In the design and operation of the plant, solutions to many novel engineering problems involving inert atmospheres, sustained high levels of radioactivity, contamination with intensely radioactive dusts, and remote installation and repair of process equipment have been developed. The operations yield primarily solid radioactive wastes for which simple methods of burial in containers have been developed. (auth)

9566 PERFORMANCE OF CENTRIFUGAL MIXER-SETTLER IN REPROCESSING NUCLEAR FUEL. Webster, D. S.; Jennings, A. S.; Kishbaugh, A. A.; Bestmann, H. K. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Contract AT(07-2)-1. Chem. Eng. Progr.; 65: Symp. Ser. No. 94, 70-7(1969).

From 60th Annual Meeting of the American Institute of Chemical Engineers, New York. See CONF-671103.

An eighteen-stage centrifugal mixer-settler, designed and developed at the Savannah River Laboratory, is now successfully separating plutonium and uranium from radioactive fission products at the Savannah River Plant of the U. S. Atomic Energy Commission. Advantages of the centrifugal equipment over the conventional mixer-settler extractor are associated principally with the fifty-fold smaller liquid volume holdup and include reduced exposure of the solvent to radiolytic degradation, increased nuclear safety, ease of flushing, and greater operating flexibility. The unit has a capacity of over 60 gal/min total flow. (auth)

9567 WAK: GERMANY'S FIRST REPROCESSING PLANT IN KARLSRUHE. Issel, Wolfgang (Gesellschaft zur Wiederaufarbeitung von Kernbrennstoffen mbH, Karlsruhe, Ger.). Chem. Eng. Progr.; 65: Symp. Ser. No. 94, 105-6(1969).

From 60th Annual Meeting of the American Institute of Chemical Engineers, New York. See CONF-671103.

A reactor fuel reprocessing plant now under construction by the Federal Republic of Germany in Karlsruhe is described briefly. The fuels are limited to uranium oxides canned in materials insoluble in nitric acid. The plant is designed to process 40 tons of UO_2 with up to 3% uranium-235 enrichment and a burnup of 25,000 Mwd/ton U on the basis of 200 operating days per year, and will provide information for the design and operation of a larger commercial facility to be built in the late 1970's. (L.C.L.)

9568 SATURATED-STEAM GENERATOR FOR STEAM-COOLED NUCLEAR REACTOR. (to Licentia Patent-Verwaltungs-GmbH). British Patent 1,177,138. 7 Jan 1970. Priority date 20 Apr 1966, Germany.

The design is given of a steam generator which produces large quantities of saturated steam outside the reactor pressure vessel in a steam-cooled reactor. The steam generator is constructed in the manner of a Löffler boiler, characterized by a plurality of water surfaces stacked one above the other. The water supply for each level is stored in a drum inside the steam generator and the design of the corresponding piping system for each water level is given. (J.C.W.)

9569 ECONOMIC ANALYSIS OF PLANTS PRODUCING CERAMIC FUEL ELEMENTS. Vesely, V. (Inst. for Nuclear Studies, Rez, Czech.); Durcik, M. pp 315-26 of Economics of Nuclear Fuels. Vienna; International Atomic Energy Agency (1968). (In Russian).

From Symposium on Economics of Nuclear Fuels, Gottwaldov, Czechoslovakia. See STI/PUB-188; CONF-680541.

Results are presented of a technical and economic evaluation of plants producing ceramic fuel elements of two different types. The first type of element consists of sintered uranium dioxide in the form of pellets; the second type consists of cast uranium monocarbide in the form of pins. The dioxide elements are clad in Zircaloy, whereas the monocarbide elements have a sheath of sintered aluminum powder. The economic performance of each plant is evaluated for five different scales of operation (from 50 to 400 tons of uranium per year). An evaluation is made of the capital investment and production costs under the economic conditions prevailing in Czechoslovakia, and the results are presented in relative quantities. With an eight-fold increase in the scale of operation, the specific capital expenditure drops by 20% for both types of fuel element. Specific production costs decrease by 30% if the cost of raw materials is excluded. Labor costs per unit of fabricated material decrease by 30% when uranium dioxide is used and by 40% when uranium monocarbide is used. (auth)

9570 ECONOMIC ASPECTS OF REPROCESSING NUCLEAR FUEL. Boesch, T.; Oszuszky, F.; Asyee, J. (EUROCHEMIC, Mol, Belg.). pp 327-38 of Economics of Nuclear Fuels. Vienna; International Atomic Energy Agency (1968).

From Symposium on Economics of Nuclear Fuels, Gottwaldov, Czechoslovakia. See STI/PUB-188; CONF-680541.

A brief critical review is given of the influence of aqueous reprocessing on the economics of the nuclear fuel cycle. On the basis of Eurochemic cost data, the economic aspects of the layout of a reprocessing plant are investigated with special regard to type and criticality. Technical and commercial experiences, after nearly two years' operation at Eurochemic, justify conclusions regarding the importance of a larger international effort in reprocessing and modesty regarding the rate of installing new reprocessing capacity on a national scale. (auth)

9571 IMPROVEMENTS IN MEANS FOR BENDING PLATES. (to Commissariat a l'Energie Atomique). British Patent 1,177,564. 14 Jan 1970. Priority date 30 Jun 1966, France.

The design and operation of a machine for bending composite plates is described. These plates consist of a core inside a casing which covers the faces of the core and encloses the lateral edges of the core. This bending method is particularly usable with plates enclosing a core of an alloy having a fissionable material as its base. A unique feature of the method is that the plates are bent solely in their central part leaving them plane at the two edges. The machine grips one edge of the plate holding that edge stationary. A bending element rolls across the plate without sliding to the opposite edge of the plate. This plate edge is restrained from bending by being gripped between two parallel surfaces, but it moves horizontally toward the first plate edge as the bending progresses. The surface shape of the bending element can be varied to produce different bend shapes. (L.C.L.)

9572 IMPROVEMENTS IN OR RELATING TO DASH POTS. Cooke, Brian Frederick (to Nuclear Power Group Ltd.). British Patent 1,175,255. 23 Dec 1969. Filed 18 Oct 1967.

Reference is made to dash pots suitable for use in nuclear reactors. The dash pot described comprises a cylinder, having openings at each end, and divided into two separate compartments by a dividing wall containing an orifice. Each compartment contains a piston, the pairs of pistons being rigidly connected together; seals are provided in the form of metallic bellows joined to the pistons and to the ends of the cylinder so as to allow movement of the pistons in the cylinder but seal the latter against the escape of fluid trapped in the compartments. Means are provided for rigidly connecting the pistons to the device whose motion is to be damped. The means interconnecting the pistons may comprise a cage member located outside the cylinder, or a rod passing through the dividing wall, leakage of fluid between the compartments where the rod passes through the wall being counteracted by a further set of metallic bellows extending between the pistons and the dividing wall. For gas cooled reactor applications the compressible fluid is preferably CO_2. (UK)

9573 EFFECTS OF SINK LEVEL AND HORIZONTAL ROOF ATTACHED TO INTAKE OPENING ON WITHDRAWAL CONDITION OF STRATIFIED FLUID. Onishi, Sotoaki (Japan Atomic Power Co., Tokyo). Proc. Jap. Soc. Civil Eng.; No. 161, 29-38 (Jan 1969). (In Japanese).

The utilization of seawater for the condensers in either atomic or steam power plants is in general practice in Japan. In the design of this intake opening, it is often economical to incorporate the idea of stratified fluid withdrawal. In this connection, the following were studied: the relationship of the level from sea-bottom of the intake opening and the flow; and the effect of a horizontal roof attached to the intake opening upon the over-all width of the opening structure. The relation was obtained between the limiting height of the opening for maintaining the stratified-fluid intake and the value of F. The formula for calculation of the required length of a horizontal roof to be attached to the intake opening was also obtained. It is known that there exists a vertical flow of water from the seawater surface toward the intake opening along the curtain wall. The installation of the horizontal roof appeared to be effective in preventing this flow in the vertical direction. (NSA of Japan)

9574 PRESENT STATE AND PROSPECTS OF NUCLEAR ENERGY IN SWEDEN. Com. Naz. Energ. Nucl., Notiz.; 15: No. 11, 80-6(Nov 1969). (In Italian).

The main nuclear power plants at present under construction in Sweden were surveyed. (auth)

9575 IMPROVEMENTS IN OR RELATING TO ELECTRON AND HEAVY PARTICLE BEAM SCANNING SYSTEMS. Mosely, John de Sola. British Patent 1,175,539. 23 Dec 1969. Filed 4 Nov 1966.

Apparatus is described for subjecting material to irradiation by a beam of charged particles, such as electrons, incident on a window which is permeable to such particles. The beam generator produces a well defined beam, and beam deflecting means are provided to give a voltage of sawtooth wave form which scans the beam across the window in such a way that the scanning trace begins its linear trace before registering with the window and extends beyond the window before commencing the return or flyback trace, the latter not being incident on the window. The beam generator and beam deflecting means may be so arranged that the effective scanning trace is spaced apart from the undeflected axis of the beam. The axis of the beam generator may be at right angles to, but literally spaced from the window, so that the undeflected beam falls on a cooled part of the window assembly and not on the window itself. The window may be composed of Ti or Al, and may be mounted in a wall member upon the surface of which the flyback trace impinges, and the wall member may be hollow and provided with cooling means. The wall member may be cooled by cold counter flow and the window by forced air. (UK)

9576 REPAIRING NUCLEAR-PLANT PIPING. Power: 114: 44(Jan 1970).

The design of the orbital vehicle cut-and-weld system at ORNL for repairing pipe in high-radiation areas of nuclear plants is discussed. The equipment consists of a large horseshoe-shaped drive assembly that moves interchangeable milling and welding heads around the pipe, a welding programmer, and a remote-control pendant. A conventional weld power source is used. (J.C.W.)

Heat Transfer and Fluid Flow

Refer also to abstracts 9516, 9573, 9604, 9607, 9620, 10213, 10417, 11184, 11195, and 11213.

9577 (AECL-3418) FREON DRYOUT CORRELATIONS AND THEIR APPLICABILITY TO WATER. Groeneveld, D. C. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Sep 1969. 36p. Dep. CFSTI (U. S. Sales Only). AECL $1.00.

Dryout results for Freon-12 in directly heated tubes (inside diameters of: 0.307, 0.431, and 0.633 in.) at a constant outlet pressure of 155 psia, were empirically correlated using an optimization technique. The correlation predicted published UKAEA Freon-12 results with an rms error of 6.64%. Optimum scaling factors were derived for each parameter of the correlation linking it with water dryout results obtained at similar conditions. The scaled, correlation predicts the water results with an rms error of 7.8%. The optimum scaling factors obtained in this study agree well with those found in a previous study. Error analysis showed that the error in predicted water critical heat flux may be in excess of 8%. (auth)

9578 (ANL-Trans-793) EXPERIMENTAL METHODS IN LIQUID METAL SYSTEMS. Subbotin, V. I.; (and others). Translated for Argonne National Lab., Ill., from pp 40-52 of Teploobmen pri Kipenii Metallov v Usloviyakh Estestnennoi Konvektsii, Moscow, 1969. 20p. Dep. CFSTI.

Certain specific aspects of temperature measurement in heat transfer experiments with boiling metals are considered. These include correction for the temperature difference in the heat-transferring wall and for the distortion of the temperature field at the point of thermocouple installation; time variation of the temperature of the fluid and of the heat-transferring wall; and variation of the characteristics of the thermocouple during the process of operation. The design and construction of microthermocouples for the measurement of high temperatures in experiments with boiling metals are discussed. (L.C.L.)

9579 (EUR-4299) EXPERIMENTAL STUDY ON HEAT TRANSFER IN PARALLEL-FLOW TUBE BUNDLES AT CONSTANT HEAT FLUX FOR MEDIUM PRANDTL NUMBERS. Rieger, M. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1969. 154p. (In German). Dep. CFSTI (U. S. Sales Only).

The heat transfer parameters were determined experimentally in electrically heated tube bundles for turbulent flow paralled to the axis. The tubes were arranged in a pattern of equilateral triangles. The ratios of the distance between the axes of the tubes to their external diameter were 1.60 and 1.25 in the two test sections studied. The bundles contained 31 heated tubes of the same diameter and were surrounded in each case by a cylindrical shell which was also equipped with electric heating. The heat flux at the surface of the tubes was about 10 W/cm^2. The wall temperatures in the bundle were measured directly with thermocouples which were embedded in the surfaces. The points of temperature measurement were chosen at numerous positions in the lateral cross-section and permitted measurement of the mean and local heat transfer coefficients in the tube bundle. The experiments were carried out with distilled water and with a mixture of 60% ethylene glycol and 40% water. The values obtained for the Prandtl numbers in this way fell within the range from 2.3 to 18. The Reynolds numbers were varied between 10^4 and 2×10^5. The relation between the mean heat transfer coefficients and the friction factor in the tube bundles is given. The experimentally determined mean Nusselt numbers are also given. For certain local Nusselt numbers deviations of up to 20% with respect to the relations given were observed. (auth)

9580 (NYO-4102-1) PROGRESS REPORT ON [AN INVESTIGATION OF PULSATING TURBULENT FLOW], JUNE 1, 1969-FEBRUARY 28, 1970. Nunge, Richard J.; Erian, Fadel F. (Clarkson Coll. of Tech., Potsdam, N. Y.). Contract AT(30-1)-4102. 8p. Dep. CFSTI.

A combined experimental and theoretical study of the fluid dynamics of pulsating turbulent flow was undertaken to obtain an understanding of the governing mechanisms in transport processes taking place during pulsating turbulent flow and to determine the basic structure of this flow field. The designs of experimental facilities for basic gas and liquid flow systems without pulsations have been completed. The motor fan assembly and plenum chamber for the gas system have been constructed. (L.C.L.)

9581 (RD/B/N-1530) DESIGN AND OPERATION OF A FORCED CONVECTION SODIUM LOOP. Dayer, N. F.; Heathman, R. J.; Hale, G. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Jan 1970. 20p. Dep. CFSTI (U. S. Sales Only).

A circulating sodium loop is described in which chemical engineering research related to sodium cooled reactor plant will be conducted. The safety and reliability of the facility has been demonstrated by lengthy continuous operation. (auth) (UK)

9582 (TID-25294) MECHANISM AND BEHAVIOR OF NUCLEATE BOILING HEAT TRANSFER TO THE ALKALI LIQUID METALS. Technical Report No. 76303-65. Deane IV, Charles W.; Rohsenow, Warren M. (Massachusetts Inst. of Tech., Cambridge. Heat Transfer Lab.). Oct 1969. Contract AT(30-1)-3357. 163p. Dep. CFSTI.

A model of boiling heat transfer to the alkali liquid metals is postulated from an examination of the events and phases of the nucleate boiling cycle. The model includes the important effect of microlayer evaporation which causes a wave of temperature depression to penetrate into the heating solids; calculated results predict the periodic boiling behavior in the heating solid as a function of the heat flux, the system pressure, the cavity size, and the thermophysical properties of the liquid and the solid. An experimental program was designed to examine the microscale boiling behavior of sodium and to verify the calculated predictions of the boiling model. Artificial cylindrical cavities are used in most of the test sections; a thermocouple is placed close to the boiling surface and adjacent to the cavity wall, and microscale temperature measurements were obtained for stable boiling of sodium from artificial cavities and also from a neutral cavity. Horizontal heating surfaces were made from nickel "A," stainless steel 316, and molybdenum-½%-titanium; the range of saturation pressure is from 20 to 780 mm Hg. Favorable comparisons with the predictions of the boiling model are obtained with data for the bubble period and for the amplitude of temperature oscillation at a thermocouple close to the boiling surface; these results indicate the importance of the microlayer in a model for boiling sodium. The effect of pressure-temperature history on incipient superheats for boiling was examined; the presence of inert gas in a cavity can lower the incipient superheat. Also, an analysis of unstable boiling indicates that outgassing from the heating solid at high temperatures can cause erratic temperature fluctuations by sporadically triggering nucleation at a previously inactive site. (auth)

9583 EXPERIMENTAL INVESTIGATION OF HEAT TRANSFER IN TUBE BUNDLES WITH PARALLEL FLOW AND A CONSTANT HEAT FLUX IN THE MIDDLE RANGE OF PRANDTL NUMBERS. Reiger, M. (EURATOM-CEN, Saclay, France). Int. J. Heat Mass Transfer; 12: 1421-47(Nov 1969). (In German).

The heat-transfer parameters were determined experimentally in electrically heated tube bundles for turbulent flow parallel to the axis. The tubes were arranged in a pattern of equilateral triangles. The ratios of the distance between the axes of the tubes to their external diameter were 1.60 and 1.25. The bundles contained 31 heated tubes of the same diameter and were surrounded in each case by a cylindrical shell which was also equipped with electric heating. The heat flux at the surface of the tubes was about 10 W/cm^2. The wall temperatures in the bundle were measured directly with thermocouples which were embedded in the surfaces. The points of temperature measurements were chosen at numerous positions in the lateral cross section and permitted measurement of the mean and local heat transfer coefficients in the tube bundle. The experiments were carried out with distilled H_2O and with a mixture of 60% ethylene glycol and 40% H_2O. The values obtained for the Prandtl numbers in this way fell within the range from 2.3 to 18. The Reynolds numbers were varied between 10^4 and 2×10^5. The relation between the mean heat-transfer coefficients and the friction factor in the tube bundles was found to be $Nu = [(RePr\zeta/8)][1 + \sqrt{(\zeta/8)}\,8.8\,(Pr - 1.3)Pr^{-0.32}]$. The experimentally determined mean Nusselt numbers were also given by the following function: $Nu = [0.0122 + 0.00245\,(p/d)]\,Re^{0.86}\,Pr^{0.4}$ with a maximum deviation of ±4%. For certain local Nusselt numbers, deviations of up to 20% with respect to the relations given were observed. (auth)(UK)

9584 FREE CONVECTION OF HEAT-GENERATING LIQUIDS IN A HORIZONTAL PIPE. Van Sant, J. H. (Univ. of California, Livermore). Nucl. Eng. Design; 10: 349-55(Jul 1969).

Maximum steady-state temperatures of freely convecting heat-generating fluids were measured experimentally. Two liquids of widely differing Prandtl and Grashof numbers were tested at many levels of internal heat generation rate in a horizontal pipe at constant wall temperature. A simplified analysis of buoyancy and viscous forces is given to show the method of correlating the temperature data. Experimental results have good correlation when presented according to the analysis. (auth)

9585 EFFECT OF THE VARIABLE VOLUME OF A RESERVOIR ON THE RESONANT FREQUENCY AND ON THE CONVECTIVE HEAT TRANSFER IN PULSATING FLOW IN A TUBE. Galitseyskii, B. M.; Danilov, Yu. I.; Dreitser, G. A.; Kalinin, E. K.; Koshkin, V. K.; Yarkho, S. A. (Moscow Aviation Inst.). Heat Transfer - Sov. Res.; 1: No. 5, 126-30(Sep 1969).

Experimental results of a study of the effect of variable volume of a reservoir, mounted at the tube inlet, on the local heat transfer coefficient distribution and on resonant frequencies are presented. It is shown that the variable volume affords the resonant frequencies to be changed and consequently affects the local heat transfer coefficient distribution. Maximum effect of gas coolant pulsations on convective heat transfer in the pipe is observed at resonant frequencies. (auth)

9586 STUDY OF POOL BOILING HEAT TRANSFER TO SODIUM AND POTASSIUM. Borishanskii, V. M.; Zhokhov, K. A.; Andreevskii, A. A.; Bobrovcich, G. I.; Putilin, M. A.; Kozyrev, A. P.; Shneiderman, L. L.; Svetlova, L. S. Heat Transfer - Sov. Res.; 1: No. 5, 65-72(Sep 1969).

An experimental study of pool boiling of liquid potassium and sodium and the analysis of data showed that the free convection heat transfer coefficient is a function of the heat flux to the power of 0.7. A weak effect of pressure ($\alpha \approx p^{0.15}$) has been established. An equation for calculation of the heat transfer coefficient is presented. (auth)

9587 ONSET OF HEAT-TRANSFER CRISIS WITH UNSTEADY INCREASE IN HEAT FLUX. Borishanskii, V. M.; Fokin, B. S. Heat Transfer - Sov. Res.; 1: No. 5, 27-55(Sep 1969).

Experimental work on the boiling heat transfer crisis attained following a jump-wise or smooth increase of the heat load to the test section was continued. Experimental equipment is described, data are presented and correlated. Comparisons with existing correlations are made. The test conditions included experiments with pool and forced convection boiling with and without subcooling. The coolants used were water, benzene, ethanol, m-bexane and n-octane. (auth)

9588 FORCED CONVECTION HEAT TRANSFER TO BOILING WATER IN PIPES AND CHANNELS. Andreev, P. A.; Alferov, N. S.; Rybin, R. A.; Shamanov, N. P. Heat Transfer - Sov. Res. 1: No. 5, 22-6(Sep 1969).

Experimental data obtained by the present authors and other investigators on heat transfer to water boiling in pipes are compared using a correlation in the form $\alpha/\alpha' = \sqrt{1 + (\alpha''/\alpha')^3}$. Satisfactory agreement with design equation was obtained. (auth)

9589 METHOD FOR ESTIMATING THE EFFICIENCY OF CONVECTIVE HEAT TRANSFER. Mitskevich, A. I. Heat Transfer - Sov. Res.; 1: No. 5, 1-21(Sep 1969).

A method for estimating the efficiency of convective heat transfer, suitable for different surfaces and coolants is presented. Examples of the use of the method are given. (auth)

9590 INVESTIGATION OF HEAT TRANSFER IN ENCLOSED VERTICAL ANNULAR GAS LAYERS. Campanile, A.; Galimi, G.; Goffi, M.; Passavanti, G. (SORIN, Saluggia, Italy). Energ. Nucl. (Milan); 16: 709-24(Nov 1969).

The problem of heat transfer by free convection in enclosed vertical gas layers is analyzed with a view to thermal insulation applications in a nuclear reactor. Measurements of heat fluxes transmitted simultaneously by conduction, convection and radiation across vertical annular layers of helium, argon and carbon dioxide are presented. Separate measurements of the rate of heat transmitted by radiation alone between the two stainless steel AISI 304 walls enclosing the annular cavity are also reported. A comparison of the experimental data with existing working formulas is made and, by correlating the present measurements, a new equation is proposed. (auth)

9591 SLUG-FLOW NUSSELT NUMBERS FOR IN-LINE FLOW THROUGH UNBAFFLED ROD BUNDLES. Dwyer, O. E.; Berry, H. C. (Brookhaven National Lab., Upton, N. Y.). Nucl. Sci. Eng.; 39: 143-50(Feb 1970).

A theoretical study of fully developed heat transfer for in-line slug flow through unbaffled equilateral triangular bundles is reported. Results are given for the pitch: diameter range 1.05 to 2.00. Two sets of thermal boundary conditions have been considered: (a) uniform wall heat flux in all directions and (b) uniform wall heat flux in the axial direction and uniform wall temperature in the circumferential direction. For the first set, results on the circumferential variation of the wall temperature are given; and for the second, those on the circumferential variation of the wall heat flux are given. For both sets, average Nusselt numbers and circumferential variations of the local heat-transfer coefficients are also given. In all cases, the results are presented in the form of convenient dimensionless groups, and it is shown that they apply to, or can be used for, the estimation of the same dependent variables for turbulent flow of liquid metals through rod bundles. It has also been shown that for the P/D ratios and Peclet numbers normally employed in liquid-metal-cooled reactor cores, the ratio of the maximum temperature variation around a rod to the average wall-to-bulk temperature drop, in the case of uniform wall heat flux in all directions, is not greatly different for both slug and turbulent flows. (auth)

Isotope Technology

Refer also to abstracts 9522, 9616, 9618, 9668, 9907, 9976, and 10213.

9592 (AGARDograph-123(Pt.1)) SPACE POWER SYSTEMS. (Advisory Group for Aerospace Research and Development, Paris (France)). Nov 1969. 348p.

The limitations of chemical propellant power systems have necessitated the development of unconventional power sources for space applications. The applicability of mechanical heat engines, radioisotope batteries, and nuclear reactors in space power systems is discussed. (L.C.L.)

9593 (AGARDograph-123(Pt.2)) SPACE POWER SYSTEMS. (Advisory Group for Aerospace Research and Development, Paris (France)). Nov 1969. 298p.

The basic concepts, characteristics, and performance of turbomachinery and alternators for space power applications are discussed. The technology of thermoelectric and thermionic energy conversion is reviewed, and the engineering aspects of thermionic energy conversion in connection with nuclear reactor applications and with flame-heated, radioisotope-powered, or solar-powered generators are presented. The design and performance of fuel cells and photovoltaic devices for space applications are described. (L.C.L.)

9594 (BNL-50195) PRODUCTION OF RADIOISOTOPES BY SPALLATION. Stang, L. G. Jr.; Hillman, M.; Lebowitz, E. (Brookhaven National Lab., Upton, N. Y.). Aug 1969. 166p. Dep. CFSTI.

In an attempt to provide a practical basis for planning to produce radioisotopes by spallation extensive tabulations of calculated yields of products from virtually every possible target element bombarded by 200-MeV protons are given. In addition, the effects of bombarding energy and choice of target on product yield are examined. Several advantages of the spallation process relative to fission are enumerated. (G.M.C.)

9595 (BNWL-1256) PACIFIC NORTHWEST LABORATORY DIVISION OF ISOTOPE DEVELOPMENT PROGRAMS. Quarterly Report, August-October 1969. Sheely, W. F. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Nov 1969. Contract AT(45-1)-1830. 40p. Dep. CFSTI.

The promethium compatibility work is continuing. A study was made of the possibility of producing 5 MCi of encapsulated cesium sources. The circuit design for the multi-element transducer concept is continuing. The scan logic, gates, preamplifier, and readout circuitry are presently undergoing development. A boron carbide/epoxy resin compound was found to be the most effective neutron shield of the candidate materials for a thermal neutron radiography camera. A basic camera design has been formulated and a prototype constructed. Sputtering parameters have been investigated using cold materials in preparation for sputter-deposition and sputter-coating alpha sources. Comparisons have been made of the relative costs of ^{238}Pu produced by Np target irradiation in power or in flux reactors. A survey of potential reactor fuel reprocessors indicate that neptunium recovery facilities will be available soon. Neutron fluence and doses were calculated at axial and radial positions from a ^{238}Pu source in a right circular tissue-equivalent phantom. (J.C.W.)

9596 (CEA-R-3598) CONTRIBUTION TO THE STUDY OF THERMAL DIFFUSION IN ISOTOPIC MIXTURES OF HYDROGEN. Lemarechal-Dupuis, Annick (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1969. 84p. (In French). Dep. CFSTI (U. S. Sales Only).

Thesis. Submitted to Paris Univ., Orsay.

Thermal diffusion constants of the mixtures H_2-HD and H_2-HT, where HD and HT were at trace concentrations, were measured between 90 and 450°K for H_2-HD and between 190 and 450°K for H_2-HT, by using the elementary effect. Furthermore, the ratio of these constants was measured by using a thermogravitational column of Clusius and Dickel, at temperatures of the hot wire between 455 and 1200°K, the cold wall being at room temperature. Comparison with the predictions of existing theories showed that the Chapman-Enskog theory could not account for the thermal diffusion of mixtures containing asymmetric molecules; the possible reasons for this disagreement are discussed. This set of measurements, combined with the results of other authors,

yields precise values at well defined conditions of temperature and concentration, useful for the determination of the coefficients of the semi-empirical expansion of Waldmann and Klemm. Furthermore some aspects of the column theory according to Furry and Jones were tested. (auth)

9597 (DP-1216) SAVANNAH RIVER LABORATORY ^{60}Co POWER AND HEAT SOURCES. Quarterly Progress Report, July-September 1969. Angerman, C. L.; Ross, C. P. (comps.) (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Nov 1969. Contract AT(07-2)-1. 28p. Dep. CFSTI.

Incentives and penalties were compared for using oxidized and alloyed forms of radioactive cobalt in heat sources. Melting temperatures were measured for CoO, $Co_{0.5}Mg_{0.5}O$, and $CoAl_2O_4$. Compatibility of the oxidized forms with rhenium was demonstrated at 1500°C. Capsules of Inconel 600 and Hastelloy C containing radioactive cobalt metal reached their goal exposure of 10,000 hr at 900°C. Tungsten capsules containing ^{60}Co can be handled for short times in air without excessive oxidation, as shown by tests at 500°C. In preliminary tests, corrosion of cobalt wafers in sea water was more rapid at defects in the nickel plating than rates reported for fully exposed cobalt surfaces. (auth)

9598 (EGG-1183-2205) MULTIPLE-SOURCE ARRAYS FOR LARGE-AREA IRRADIATION. Technical Report Number S-450-R. Quam, W.; Rainbolt, C. (EG and G, Inc., Goleta, Calif.). Mar 1969. Contract AT(29-1)-1183. 24p. Dep. CFSTI.

See also CAPE-1943.

Irradiation systems capable of providing a uniform dose rate over relatively large land areas are required for investigating the ecological effects of ionizing radiation on plants and small animal populations. In this study, simple computational methods were used to obtain approximations of the effectiveness of multiple-source arrays made up of ^{60}Co and ^{137}Cs sources atop thin poles spaced at regular intervals. Dose rate distributions, efficiencies, and figures of merit are presented in tabular and graphical form for two basic array configurations and ninety different source-height and spacing arrangements. (auth)

9599 (MMM-3824-41) SNAP-23A PROGRAM, PHASE I. THERMOELECTRIC CONVERTER DEVELOPMENT PROGRAM. Monthly Report, October 1969. (Minnesota Mining and Mfg. Co., St. Paul. Electrical Products Group). 20 Nov 1969. Contract AT(30-1)-3824. 29p. Dep. CFSTI.

Activities conducted included completing the design of all components for PMC-2 and completing its assembly. Technical liaison continued on the system-converter interface for PMC-2. The assembly of the first two fire safety modules was completed and the analysis of problems occurring during processing of SNAP-23A converter PMC-2 was initiated. Test data evaluation was performed on EMC-2, EMC-3, PMC-1B, and the 10-couple modules 1 and 3. (J.C.W.)

9600 (NUMEC-3731-21) RADIOISOTOPE POWERED CARDIAC PACEMAKER DESIGN OBJECTIVE OPTIMIZATION. Phase I. (Nuclear Materials and Equipment Corp., Apollo, Pa.). Sep 1969. Contract AT(30-1)-3731. 50p. Dep. CFSTI.

The attainment of the design objectives in the development of a ^{238}Pu-powered cardiac pacemaker is examined. These objectives include specifications related to reliability, material quality assurance, size and weight, thermal insulation, design life, fuel capsule integrity, radiation limitations, sterilization requirements, electrical output, pacing performance, component characteristics, and ability to withstand shock loadings during transport and storage. (L.C.L.)

9601 (NUMEC-3731-22) RADIOISOTOPE POWERED CARDIAC PACEMAKER SYSTEM DESIGN DESCRIPTION. Phase I. (Nuclear Materials and Equipment Corp., Apollo, Pa.). Sep 1969. Contract AT(30-1)-3731. 34p. Dep. CFSTI.

The design of a radioisotope-powered cardiac pacemaker is described. The complete system contains a nuclear battery which consists of a plutonium-238 heat source triply encapsulated in successively hermetically sealed cylinders of Ta-W, Hastelloy C, and Ti, and electronics assembly sealed within a separate hermetic Ti enclosure, and a commercial cardiac lead termination which is positioned in epoxy. The nuclear battery outer case serves as the second electrode. The design specifications, operating principles, and maintenance and safety requirements of the pacemaker are given in detail. The prototype system described has a 10 yr minimum operating life with 0.95 reliability at 0.90 confidence, and is believed to represent an optimum design which is suitable for animal testing. (L.C.L.)

9602 (ORNL-IIC-27) LIST OF AEC RADIOISOTOPE CUSTOMERS WITH SUMMARY OF RADIOISOTOPE SHIPMENTS, FY 1969. Curl, Ruth (comp.) (Oak Ridge National Lab., Tenn.) Jan 1970. Contract W-7405-eng-26. 27p. Dep. CFSTI.

The AEC radioisotope customers and the radioisotopes purchased during FY 1969 are itemized. A listing describing the shipments is also included. (G.M.C.)

9603 (SC-DR-69-792) ISOTOPES INTACT IMPACT HEAT SOURCE DROP TESTS. Entrekin, J. L. (Sandia Labs., Albuquerque, N. Mex.). Nov 1969. 138p. Dep. CFSTI.

Twenty-one items comprising four different heat source and capsule shapes were drop tested at the Tonopah Test Range to obtain terminal velocity data and full reduced trajectory data. A secondary objective was the acquisition of data related to crater and soil characteristics. Photographs of the samples, before and after impact, and full trajectory data are presented. (auth)

9604 (SC-RR-69-353) ABLATION AND THERMAL RESPONSE OF THE SNAP-27 GRAPHITE LM FUEL CASK DURING MULTIPLE ORBIT REENTRY. Larson, D. W. (Sandia Labs., Albuquerque, N. Mex.). Nov 1969. 126p. Dep. CFSTI.

The ablative response of the SNAP-27 Graphite LM Fuel Cask (GLFC) is presented for each pass through the atmosphere in a multiple orbit atmospheric reentry for several initial perigee altitudes. The thermal response of the GLFC is presented for one pass through the atmosphere during a multiple orbit reentry. (auth)

9605 USE OF ISOTOPES AND RADIATION SOURCES IN HYDROLOGY. Alekseev, F. A.; Churaiev, I. V.; Yakovlev, A. I.; (and others). Tr., Vses. Nauch.-Issled. Inst. Yadern. Geofiz. Geokhim.; No. 1, 41-60(1968). (In Russian).

The use of isotopes and radiation sources in hydrology is described in connection with the following problems: investigation of flow in soils, erosion processes, the dynamics of alluvium, and the dynamics of open streams of water; use of tritium to determine sources of flooding and to estimate the extent of percolation of meteoric waters into the crust; radioactive profiling of surface formations; and observation of migrations of moisture in the zone of aeration by the gamma penetration method. (Geophys. Abstr.)

9606 ON THE PROPERTY OF RADIOGRAPHIC ^{192}Ir SOURCE. I. Hanai, Masaru; Asaba, Yukio (Shizuoka Prefectural Industrial Research Inst., Japan). Rep. Prefect. Ind. Res. Inst., Shizuoka; No. 13, 137-41(Feb 1969). (In Japanese).

Recently, homemade ^{192}Ir was put to practical use as a radiographic source with good results. The use of ^{192}Ir for the nondestructive inspection of metals was tested. The results were as follows: Penetrability of ^{192}Ir showed the difference of defects in metals with an increase in thickness. On the radiographic films contrast of ^{192}Ir was between that of ^{60}Co and x ray. Exposure time of ^{192}Ir was between that of ^{60}Co and x ray and better discrimination for defects was obtained by use of fine grain films. Discrimination for defects was not little affected by the difference of atomic number and thus it was nearly equal between steel and copper. (auth) (NSA of Japan)

9607 NEUTRON ACTIVATION STUDY OF SMALL PARTICLE ABLATION. Kenna, B. T.; Harrison, P. E. (Sandia Labs., Albuquerque, N. Mex.). Int. J. Appl. Radiat. Isotop., 20: 777-89(Nov. 1969).

The studies described were conducted in connection with the problem of radioactive debris disposal from the use of radioisotopic fuels in SNAP sources. If the fuel capsules are to be destroyed in the process of re-entry there must be assurance that fuel particle ablation presents no health hazard. The studies illustrate the feasibility of determining ablation characteristics of small particles by simulating re-entry conditions using a light-gas gun facility. Quantitative data are obtained through neutron activation analysis. It is possible that a study of small particles of one type of material can permit prediction with some assurance of the ablation characteristics of a different material by correlation with Weber's Number. The ablation of gold particles is sometimes found to include major breakup of the initial gold microspheres. This is postulated to be due in part to the formation of a gold oxide film on the molten surface of the particle. (auth) (UK)

9608 ECONOMICS OF URANIUM ENRICHMENT BY GASEOUS DIFFUSION. Martensson, M. (Aktiebolaget Atomenergi, Stockholm). pp 275-95 of Economics of Nuclear Fuels. Vienna; International Atomic Energy Agency (1968).

From Symposium on Economics of Nuclear Fuels, Gottwaldov, Czechoslovakia. See STI/PUB-188; CONF-680541.

An economic theory of uranium enrichment by gaseous diffusion

must be based on three different areas of scientific knowledge: the theory of separation cascades, in particular square cascades; the theory of diffusion membranes; and the chemistry and physicochemistry of uranium hexafluoride. In fact, each of these fields is sufficiently known to be used for making up a complete economic theory of the gaseous diffusion process. A computer model is described where the cascade theory and the membrane theory are integrated into one whole. This is done essentially by replacing the enrichment coefficient ϵ, which is treated as a constant in the cascade theory, by a function of several variables. This function is derived from the membrane theory, i.e., the theory of separation of gaseous mixtures flowing through porous media. The variables of the function are the main working parameters of a gaseous diffusion plant, viz., the fore pressure (the pressure of UF_6 before its passage through the membrane), the back pressure, the working temperature, the mean pore radius characterizing the membrane, and the cut (the ratio of diffused flow to total flow). The third of the three above-mentioned fields is incorporated into the computer model as boundary conditions that restrict the working parameters within limits determined by the chemical and physicochemical properties of uranium hexafluoride. The purpose of the computer program is to optimize the design (i.e., the number of stages and the stage flow) and the working parameters of a diffusion cascade (made up of one or more cascades) for production of a given amount of uranium with a given enrichment. This optimization means that the least sum is determined by three main cost items: the cost of the feed, the cost of electricity, and the annual fixed plant costs. The latter are in turn a sum of the costs of the different components making up the plant: compressors, diffusers, heat exchangers, pipes, and valves. To complete the computer model, therefore, the costs of these components must be expressed as a function of the stage flow and the main working parameters. These cost functions, which are of a purely empirical nature, are not known in detail but tentative estimates of them are presented. Results of computation are also given. (auth)

9609 ECONOMIC EVALUATION ON CERTAIN ELEMENTS FROM SPENT POWER REACTOR FUEL ELEMENTS. Com. Naz. Energ. Nucl., Notiz.; 15: No. 11, 72-9(Nov 1969). (In Italian).

The major data from a Battelle Memorial Institute study on the economic feasibility of the recovery of certain elements from spent power reactor fuels are given. (auth)

Materials Testing

Refer also to abstracts 9547, 9555, 9603, 9606, 9698, 9987, 9990, 10003, 10046–10048, 10051, 10076, 10130, 10890, and 11132–11146.

9610 (KFK–985, pp 161-81) VARIOUS TESTING METHODS FOR CANNING MATERIAL SELECTION AND THEIR ACTUAL VALUE. Laue, H. J. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Reaktorphysik). (In German).

The testing methods available for the evaluation of canning materials in the presence of sodium and neutron irradiation are described and illustrated. The techniques used in carrying out the tests are briefly indicated. The factors affecting the evaluation of the test results are critically analyzed. The possibilities of computer simulation are considered. (J.S.R.)

9611 (KFK–985, pp 419-29) SPECIAL PROBLEMS IN CANNED TUBE TESTING. Zutz, L. (Allgemeine Elektricitaets-Gesellschaft, Grosswelzheim (West Germany)). (In German).

The extensive reactor development places more rigid requirements on the fuel element canning tube. The selection of suitable test methods and its economy is a decisive factor for the quality of such tubes. Some further developments of test installations by the producer and processer, connected with corresponding test experiences, lead to useful test results. The testing with two test heads with separate signal characterization of the internal and external error of the too resounding tube wall is of special advantage. The introduction of uniform test standards was recommended in which a simultaneous classification of tube quality appears practical. (tr-auth)

9612 (KFK–985, pp 431-49) CANNED TUBE TESTING: METHODS AND RESULTS. Braun, H. (Siemens A. G., Erlangen (West Germany)). (In German).

The methods used for fissure testing, wall thickness measurements, internal diameter measurements, and external diameters of fuel cans are described and critically discussed. The results showed that the test methods used by the producer for the accuracy of the tube dimensions and stability were adequate. (J.S.R.)

9613 (ORNL–TM–2673) POSTIRRADIATION NONDESTRUCTIVE EXAMINATION OF THE SM-2B FUEL ELEMENT FROM THE ARMY SM-1 POWER REACTOR. Richt, A. E.; Haynes, V. O. (Oak Ridge National Lab., Tenn.). Jan 1970. Contract W-7405-eng-26. 19p. Dep. CFSTI.

Results are given of the inspection of the experimental fuel element, SM-2B, after 13.5 MWyrs of service in the Army SM-1 Stationary Medium Power Reactor. The purpose of the inspection was to determine if the element was dimensionally and structurally suitable for testing to its design lifetime of 28.0 MWyrs. Results of this inspection indicated that the fuel element is acceptable for continued testing in the SM-1. No evidence of gross structural damage was apparent, gamma scans showed no indications of abnormalities in the fuel burnup distribution, and the external dimensions of the element were within acceptable limits. A few small intergranular cracks may be present in the cladding of the fuel plates but are thought to present no significant hazard to the reactor. The fuel element appeared to be suitable for continued testing and was returned to the SM-1 site. (auth)

9614 EXPERIMENTAL STUDIES ON THE CORRESPONDENCY BETWEEN DEFECTS AND NONDESTRUCTIVE TEST IMAGES AND THE EFFECT OF DEFECTS ON TENSILE STRENGTH IN STEEL PLATES AND WELDS FOR A REACTOR PRESSURE-VESSEL. 1. Yosetsu Gijutsu; 17: No. 7, 77-91 (Jul 1969). (In Japanese).

The establishment of criteria for the nondestructive testing of reactor pressure vessels by means of the correspondence between defects and images, and the effect of defects on mechanical strength was investigated. The relations between defects and nondestructive test images were studied for different thicknesses of SB steel plate. In many cases, rupture occurred at a position where the largest defect region was detected by sonic inspection. On the whole, no rupture occurred in the specimens without defect echo. A defect in the direction of plate thickness, corresponding to a fracture, was detected well. Due to overlapping, a defect was indicated larger than actual size. In some cases, defects at deeper position than a fracture were not detected. The tensile strength and the evaluation by supersonic flaw test was in general agreement. (NSA of Japan)

9615 EXPERIMENTAL STUDIES ON THE CORRESPONDENCY BETWEEN DEFECTS AND NONDESTRUCTIVE TEST IMAGES AND THE EFFECT OF DEFECTS ON TENSILE STRENGTH IN STEEL PLATES AND WELDS FOR A REACTOR PRESSURE-VESSEL. 2. Yosetsu Gijutsu; 17: No. 8, 77-88 (Aug 1969). (In Japanese).

Criteria for nondestructive testing of reactor pressure vessels were investigated. The quantitative relations between defects and nondestructive testing images were studied for the butt welds of SB steel plates with different thicknesses. Defects were observed by cutting, and two methods of nondestructive testing including radiation penetration (RP) and supersonic (S), were compared. In testing a 50-mm thickness steel plate for slag-inclusions and blow-holes, RP detected defects, but S was not as effective as RP. For specimens of insufficient weld penetration, only combined RP and S were able to detect defects. For cracked specimens, S detected them, but RP did not. In tests of 100-mm thickness steel plate for blow-hole and slag-inclusions, RP gave good results. For specimens of insufficient weld penetration, on the whole, RP was not effective, but S gave satisfactory results. In tests of 200-mm thickness steel plate for blow-hole and slag-inclusions, RP was effective for defects down to 2% of the plate thickness. S detected blow holes and slag inclusions in the middle of the plate. For specimens of insufficient weld penetration, RP was effective for defects down to 6% of the plate thickness. (NSA of Japan)

9616 OPTIMUM AND PERMISSIBLE THICKNESS IN RADIATIONAL DEFECTOSCOPY AND SELECTION OF γ-RADIOACTIVE SOURCES. Tsvetkov, Tsvetan. Tekh. Misul; 6: 103-9(1969). (In Bulgarian).

An attempt was made to classify the γ-radioactive sources according to their use in defectoscopy. ^{152}Eu, ^{60}Co, and ^{134}Cs were the best sources for very thick targets and can be used for targets with an average thickness. ^{152}Eu, ^{60}Co, ^{134}Cs, ^{137}Cs, ^{192}Ir, and ^{75}Se sources were best suited for the irradiation of targets with an average thickness. ^{75}Se, ^{144}Cs, and ^{170}Tm were the best sources for the irradiation of thin targets. (Selenium-Tellurium Abstr.)

9617 IMPROVEMENTS IN OR RELATING TO RADIOGRAPHIC APPARATUS FOR EXAMINING WELDS. Stewart, Roy; Tucker, James (to United Kingdom Atomic Energy Authority). British Patent 1,174,932. 17 Dec 1969. Filed 16 Mar 1966.

The apparatus described for the examination of annular welds such as in reactor fuel elements, comprises means for supporting the object to be inspected in a stationary position, a radiation

source unit capable of producing a narrow near-parallel beam of penetrating radiation, and a container unit for radiation-sensitive film with means for moving the film past an exposure aperture. Means are provided for mounting the two units in such a way that they can be moved together in a planetary manner bodily around the object to be inspected, with the units disposed on opposite sides of the object; means are also provided for relating the planetary movement of the units to the movement of the film past the exposure aperture, whereby the radiation beam can be made to scan around the annular weld to produce a linear record thereof on the film. Various alternative drive arrangements are described. (UK)

Radioactive Material Handling

Refer also to abstracts 9465, 9488, 9567, 9607, 10145, 11104, and 11129–11131.

9618 (CEA-tr-R-1971) PROCESS FOR CLEANING SOILED SURFACES OF ^{147}Pm AND ^{239}Pu SOURCES FOR RADIOISOTOPIC STATIC ELECTRICITY ELIMINATORS. Vershinin, N. V.; Dovgul, S. P. Translated from Izotopy SSSR, 9: 30-1(1968). 4p. (In French). Dep. CFSTI (U. S. Sales Only).

For cleaning the surfaces of ^{147}Pm and ^{239}Pu sources for static electricity eliminators of accumulated oils, paints, pastes, and other organic encrustations, a 5% mixture of an aqueous solution of ammonium citrate and ammonium nitrate with the addition to the mixture of an equal volume of ethyl alcohol or other organic solvent is discussed. The encrustation remaining after treatment with this mixture is from 1 to 10% for ^{147}Pm sources and from 4 to 10% for ^{239}Pu sources of the initial level. (J.S.R.)

9619 (DUN-SA-125) DEVELOPMENT OF A WASTE DISPOSAL METHOD FOR N REACTOR'S DECONTAMINATION WASTES. Kratzer, W. K.; Bainard, W. D. (Douglas United Nuclear, Inc., Richland, Wash.). 5 Nov 1969. Contract AT-(45-1)-1857. 14p. Dep. CFSTI.

The evolution of the decontamination waste disposal plans made as N Reactor was designed, constructed, tested, and operated is reviewed. Early concepts were for ground disposal, later modified to on-site concentration by evaporation, then finally to the concept actually in use, which is shipment of the wastes by railroad to an existing concentration facility. In the past four years, over 4,000,000 gallons of waste have been shipped and processed with no serious incidents. (J.C.W.)

9620 (EUR-4402) RADIOACTIVE TRACER TECHNIQUE TO STUDY THE HYDRODYNAMIC BEHAVIOUR OF AN EFFLUENT DECONTAMINATION PLANT. Lopes Cardozo, R.; Vaccarezza, J.; Monfrini, C.; Vanuzzi, S. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). 5 Sep 1969. 20p. Dep. CFSTI (U. S. Sales Only).

Some radioactive tracer experiments for the determination of the hydrodynamic behavior of a plant used for decontamination of 2.5 m^3/hr of radioactive effluent are described. ^{131}I was used as the tracer. The equipment consisted of a mixer and a flocculator. It was shown that the mixer behaved ideally and that the flocculator was functioning in a rather inefficient way. Some possible improvements of the equipment are indicated. (auth)

9621 (NYO-841-20) HARVARD AIR CLEANING LABORATORY. Semiannual Progress Report, March 1–August 31, 1969. First, M. W.; Goldin, A. S.; Reist, P. C.; Underhill, D. W.; Viles, F. J. Jr.; Baldwin, T.; O'Brien, M.; Yusa, H.; Moeller, D. W. (Harvard Univ., Boston, Mass. Harvard Air Cleaning Lab.). Oct 1969. Contract AT(30-1)-841. 93p. Dep. CFSTI.

A summary of research on air cleaning processes is reported. Tests were conducted on industrial cleanable glass fabric filters using backflow of air as a cleaning mechanism between filtration cycles for removal of sodium aerosols. Theoretical evaluations of the latest design basis accidents (DBA) for the FFTF showed that there will be no need for a pebble bed heat-sink in a cleanup system using high temperature resistant fabric filters. An analysis of the accident situation resulting from Na releases of various magnitudes was made and procedures are suggested for cleanup. An analysis was made of an FFTF sodium release accident when ^{24}Na is in the coolant following the accident, but the iodine present will be tied up with the sodium establishing the potential hazard of the sodium aerosol. Examination of experimental data showed that thermophoresis can be an important mechanism for the deposition of sodium fumes from turbulent flow onto the inside of a pipe wall. A system of equations was developed which provides a new approach to understanding dynamic gas adsorption. (J.C.W.)

9622 (Y-1703) ANALYSIS OF FISSILE MATERIAL STORAGE AND SHIPPING AT THE Y-12 PLANT. Crume, E. C. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). 8 Jan 1970. Contract W-7405-eng-26. 17p. Dep. CFSTI.

Various techniques are utilized in the criticality safety analysis of fissile material shipments and storage at the Oak Ridge Y-12 Plant. In recent years, emphasis has been placed on the utilization of EDPM techniques, especially the newly developed KENO criticality calculational program, to satisfy current technical and economic requirements. While the range of applicability of such techniques already includes most current Y-12 Plant applications, work is in progress to extend it by improving the neutron interaction cross sections used in the criticality calculations. (auth)

9623 NEW INTERPRETATION FOR THE TRANSPORT OF NUCLEAR MATERIALS FOLLOWING A SMALL AMENDMENT TO THE ATOMIC LAW. Blechschmidt, M. PTB Mitt.; 79: 368-9(Oct 1969). (In German).

A new amendment to the German Atomic Law adjusts the regulations relating to the transport of nuclear materials largely to the international standard. The transport approval is now given to the shipper or to the person undertaking to manage the shipment. The third party liability for the transport is channeled to the operator of the nuclear installation. Fuel element factories now are nuclear installations. (auth)

9624 METHOD OF PREVENTING PLUTONIUM LEAKAGE. Wohlberg, Cornel (to United States Atomic Energy Commission). U. S. Patent 3,486,979. 30 Dec 1969.

A tantalum container for plutonium fuels rendered resistant to leakage of the plutonium fuel by incorporation of zirconium carbides into the grain boundaries of the tantalum is described. The container was made by adding carbon to the tantalum in an amount of about 120 ppM, arc melting the tantalum and zirconium carbide (source of carbon), and melting the resulting mixture repeatedly. (AEC)

9625 RADIOACTIVE CONTAMINATION OF THE OCEAN. Makihara, Kenji. J. Pollut. Contr.; 5: 255-63(Apr 1969). (In Japanese).

Contamination of the ocean by radioactivity is proceeding because of nuclear detonations and atomic-powered ships. The current rapid increase in atomic installations will have a grave influence in the future not only on the fisheries but also on the health of human beings. Radioactive contamination of the ocean is described in terms of: importance of the radioactive contamination of the ocean; concentration and accumulation of radioactivity in the marine life and plants; characteristics of public hazards and the Minamata disease; public hazards of atomic energy; monitoring system and international treaty concerning the radioactive contamination of the oceans. (NSA of Japan)

9626 REMOVAL OF THE CORE OF A URANIUM FUEL ELEMENT FROM ITS CLADDING. (to State of Israel, Atomic Energy Commission). British Patent 1,176,580. 7 Jan 1970. Priority date 19 Feb 1968, Israel.

A method is given for the removal of the core of a uranium fuel element from its cladding. The cladding may be aluminum or aluminum alloys, inconel, stainless steels, or Zircaloy-2. The element is immersed in 8 to 11 N nitric acid at 25 to 80°C. The fuel element is kept within the bath until the core is extractable, the element is removed from the bath, and the core is extracted therefrom. (J.C.W.)

9627 DESIGN OF PLANT FOR INCORPORATION OF HIGHLY ACTIVE WASTES INTO GLASS. Clelland, D. W.; Corbet, A. D. W.; Coles, R. F. (United Kingdom Atomic Energy Authority, Risley, Eng.). Chem. Eng. Progr.; 65: Symp. Ser. No. 94, 89-101(1969).

From 60th Annual Meeting of the American Institute of Chemical Engineers, New York. See CONF-671103.

Over the last 10 years the problem of disposal of highly active wastes, arising from the reprocessing of irradiated fuel from nuclear power systems, has attracted much attention and has been the subject of considerable development work. At the International Conference on Waste Storage in Vienna in 1963, a process for incorporating these wastes in a chemically inert and highly insoluble glass (fingal process) was generally considered to be of major importance because of the enhanced safety which it offers for permanent storage systems. The results of a recent engineering assessment from which a plant design has been evolved for incorporating highly active wastes into glass and for storing this material in a safe manner over a long period of time are reported. (auth)

9628 REPROCESSING PROJECT IN JAPAN. Ishikawa, K.; Sato, S. Chem. Eng. Progr.; 65: Symp. Ser. No. 94, 102-4(1969).

From 60th Annual Meeting of the American Institute of Chemical Engineers, New York. See CONF-671103.

The design of a "chop-leach" type spent fuel reprocessing plant to be completed in Japan in 1971 is discussed with brief descriptions of the fuel types to be reprocessed, the process itself, methods for handling and storing liquid and solid radioactive wastes from the process, and special considerations such as remote maintenance, criticality control, and containment which were used in the design of the plant. (L.C.L.)

9629 AN ANALYSIS OF COST PARAMETERS FOR THE TRANSPORT OF IRRADIATED FUELS FROM PLUTONIUM BREEDERS. Gupta, D.; Kraemer, R.; Hagen, H. (Kernforschungszentrum, Karlsruhe, Ger.). pp 543-55 of Economics of Nuclear Fuels. Vienna; International Atomic Energy Agency (1968).

From Symposium on Economics of Nuclear Fuels, Gottwaldov, Czechosiovakia. See STI/PUB-188; CONF-680541.

As opposed to other branches of the nuclear fuel industry, such as fabrication or reprocessing plants, the transport casks for irradiated fuel elements for fast breeders cannot take full advantage of savings through scaling up. The largest size and therefore the largest weight of the cask as well as the largest ratio of transported-fuel-to-cask weight are fixed by non-economic considerations. However, the transport costs per kilogram of irradiated fuel are sensitive to some other parameters. For example, they increase slowly with decreasing cooling time as the cask weight increases. The capital charges for the transport cask expressed in DM/kg fuel decrease hyperbolically with increasing number of trips per year whereas the insurance, freight and operational charges are independent of the number of trips in a year. Here it has been shown that the most important parameter influencing the transport costs is the number of trips per cask and year. In an expanding nuclear economy the expected number of trips will be about 30 to 40 per cask and year, giving rise to transport charges of about DM 20/kg fuel. (auth)

9630 ITALY'S REGULATIONS ON THE TRADE IN RADIOACTIVE MATERIALS. Com. Naz. Energ. Nucl., Notiz.; 15: No. 11, 90-4(Nov 1969). (In Italian).

The existing Italian regulations on the sale of radioactive materials are reviewed. (auth)

Vacuum Engineering

9631 (AEC-tr-7106) HELIUM PUMPING BY CONDENSED LAYERS OF GAS IN THE PRESSURE INTERVAL 10^{-9} TO 10^{-12} TORR. Yuferov, V. B.; Kobzeb, P. M. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). Translation of report FTI-231. 9p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 23: 38233. (auth)

INSTRUMENTATION

Radiation Detection Instruments

General Detectors and Monitors

Refer also to abstracts 9373, 9706, 9721, 10891, 11154, 11254, and 11334.

9632 (BARC–403) PHOTO- AND DOUBLE-ESCAPE PEAK EFFICIENCIES OF CYLINDRICAL Ge(Li) DETECTORS. Lal, B.; Iyengar, K. V. K. (Bhabha Atomic Research Centre, Bombay (India)). 1969. 24p. Dep. CFSTI (U. S. Sales Only).

Monte Carlo calculations have been made to compute the full energy peak efficiencies and the double escape peak efficiencies for right circular cylindrical Ge(Li) detectors for point gamma-ray sources. The full energy peak efficiencies are calculated in the gamma-ray energy range from 100 keV to 2.5 MeV and the double escape peak efficiencies are calculated in the range from 1.7 MeV to 4.0 MeV. All calculations have been made for a source to detector distance of 5 cm. Various detector sizes have been considered with surface area varying from 2.5 cm^2 to 8.0 cm^2 and the thickness varying from 2.0 to 10.0 mm. The calculated efficiencies are compared with the available experimental values for one of the detectors for a parallel gamma-ray source. A code "MONTCARL" has been developed for this purpose in FORTRAN language for the CDC-3600 computer. The same code can be used to calculate the response function of the detector to gamma-rays. One such calculation has been made for monoenergetic gamma-rays and it compares very well with the experimental result. (auth)

9633 (BNWL-SA–2096) CALIBRATION AND FIELD USE OF IONIZATION CHAMBER SURVEY INSTRUMENTS. Howell, W. P.; Kathren, R. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jan 1969. Contract AT(45-1)-1830. 11p. (CONF-690103–18). Dep. CFSTI.

From Health Physics Society Midyear Topical Symposium, Los Angeles, Calif.

Measurement accuracy of ion chamber survey instruments in field survey situations is affected by both the calibration procedures and the geometric relationship between the radiation source and the chamber. The fundamentals of the calibration method used at Hanford for ion chamber instruments are described, and the resulting capabilities of the instruments in field survey situations presented. Additional corrections to calibrated instrument results are ordinarily required when measuring small beams, radiation fields associated with large beta sources, and radiation levels where the chamber is in contact with the source. The method of determining the required corrections, and the values of the correction factors are described for one widely used CP ion chamber survey instrument. (auth)

9634 (COO–1195-176) MEASUREMENTS OF EFFICIENCY AND TIME RESOLUTION OF MULTIWIRE PROPORTIONAL COUNTERS. Koester, L. J. Jr.; Koetz, U.; Segler, S. (Illinois Univ., Urbana). Dec 1969. 19p. Dep. CFSTI.

Efficiency measurements of multiwire gas proportional counters in a 1 GeV/c particle beam are described. Results are presented as a function of the location of the particle traversal relative to the wires. Timing spectra relative to coincident scintillation counters show that 99.5% efficiency can be achieved throughout the sensitive area with a full width time resolution of 60 ns. Counter construction is outlined, and a new integrated circuit amplifier-discriminator is presented. (auth)

9635 (FMRB–29/69) EXHAUST MONITOR IN NEW CONSTRUCTION FOR RADIOCHEMISTRY AND ITS CALIBRATION. Rassl, G. (Physikalisch-Technische Bundesanstalt, Brunswick (West Germany)). Jul 1969. 20p. (In German). Dep. CFSTI (U. S. Sales Only).

A device is described installed in the radiochemical laboratory of the Physikalisch-Technische Bundesanstalt in order to control and to record the specific activity of the exhaust air. Measurements are reported, with punctate sources of known activity which are performed and analyzed to obtain the counting efficiency as a function of the specific activity of the exhaust air and of the radionuclide under investigation. For a special proportional flow counter with methane as counting gas and with a sensitive area of 1400 cm^2 (on each side half of it) doubling of the background counting rate has been evaluated at: ^{204}Tl: $2,2 \cdot 10^{-4}$ $nCi \cdot cm^{-3}$; ^{32}P: $1,3 \cdot 10^{-4}$ $nCi \cdot cm^{-3}$, and ^{144}Ce: $0,17 \cdot 10^{-4}$ $nCi \cdot cm^{-3}$. (auth)

9636 (GEMP–729) PROGRAM DOS, NSP-874, A FORTRAN IV PROGRAM TO COMPUTE THE FLUX OR SPECIFIC ACTIVITY ASSOCIATED WITH A DOSIMETER. Baumgardt, N. R.; Henderson, W. B. (General Electric Co., Cincinnati, Ohio. Missile and Space Div.). Dec 1969. Contract AT(40-1)-2847. 34p. Dep. CFSTI.

DOS is a FORTRAN IV program written for the GE-635 computer to deduce the local neutron flux per reference power level which will produce the measured activity of a dosimeter. The dosimeter may have been irradiated in as many as 100 power cycles, each of which may have been at a different power level. Alternatively, if the flux value is supplied, the corresponding dosimeter activity will be calculated. The types of dosimeters treated are those in which neutron irradiation of the parent isotope leads to a ground state and a metastable state of the radioactive daughter, or to a ground state only. (auth)

9637 (IFVE-SEF–69-7) THE DIFFERENTIAL-THRESHOLD CHERENKOV COUNTER. Prokoshkin, Yu. D. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii). 1969. 11p. (In Russian). Dep. CFSTI (U. S. Sales Only).

A modification of the Cherenkov counter (a differential-threshold Cherenkov counter) is described. The counter has high resolution and a large angular sperture. (auth)

9638 (N–69-38766) AN IMPROVED DELAYED NEUTRON FISSION PRODUCT MONITOR. Heckelman, James D.; Semenchuk, Konstanty (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Oct 1969. 21p. (NASA-TM-X–1886). CFSTI.

The fission product monitor (FPM) developed at NASA's 60-megawatt (thermal) test reactor at the Plum Brook Station is described. Two neutron detectors are used to monitor the delayed neutrons at two different locations in the primary coolant system. The ratio (detector 1 count rate)/(detector 2 count rate) is used to indicate the presence of fission products. During normal reactor operation when significant fission products are not present in the primary cooling water (PCW), the neutrons present at the detectors are from the decay of nitrogen 17. When fission products appear in the PCW, their half-lives are different from the half-life of ^{17}N. The ratio will thus change, and the change may be uniquely related to the fission product activity in the PCW. The activity of the fission product iodine-134 in the PCW of the Plum Brook Reactor is routinely determined. Calculations provided the theoretical FPM ratios for assumed ^{134}I levels. The theoretical curve was then verified by actual measurements taken during many reactor operating hours. Calibration of the FPM system is easily accomplished by interchanging the detectors at one detector location and adjusting the electronics so that the counting rates of both detector channels are equal. The monitor is in operation and has demonstrated reliable results. (auth) (USGRDR)

9639 (NYO–3937-1) POSITRON SCANNING WITH COMPUTER INTERFACE. Technical Progress Report, January 1–December 31, 1969. Brownell, Gordon L. (Massachusetts General Hospital, Boston. Physics Research Lab.). Contract AT(30-1)-3937. 28p. Dep. CFSTI.

The development of a hybrid positron camera with a PDP-9 data processing system is outlined. Also, developments at the 6-MeV deuteron cyclotron are discussed including production and labelling studies of oxygen-15, nitrogen-13, and carbon-11. Biological applications of short-lived radioisotopes are briefly considered, and a brief description of the computer interface and image processing and display system is given. (W.H.K.)

9640 (ORNL-TM–2594) RESPMG: A RESPONSE MATRIX GENERATION CODE PACKAGE. Burrus, W. R.; Freestone, R. M. Jr. (Oak Ridge National Lab., Tenn.). 25 Nov 1969. Contract W-7405-eng-26. 81p. Dep. CFSTI.

In the unfolding of the complex pulse-height spectra resulting from the interaction of neutrons with an organic scintillator such as NE 213, an accurate and detailed matrix of monoenergetic response functions is needed. RESPMG is a package of FORTRAN codes which operate on a relatively small number of input response functions, generated by the Monte Carlo code 05S or otherwise, to produce such a matrix. Input to RESPMG, other than the response functions, is simple and straightforward. Output consists of tabulations of the results, page-printer plots of selected responses, and a deck of punched cards suitable for input, in particular, to the unfolding codes COOLC and FERDOR. Complete descriptions of all subroutines, including flowcharts are given, plus a users' manual or "cookbook" section giving detailed instructions for using the codes. (auth)

9641 (SLAC–108) PULSE SHAPE IN MULTIWIRE PROPORTIONAL WIRE CHAMBER. Mitra, Sanjit K. (Stanford Linear Accelerator Center, Calif.). Dec 1969. Contract AT-(04-3)-515. 47p. Dep. CFSTI.

An analytical expression for the input pulse generated at the anode is derived along with an approximate expression for the amplifier output pulse from a multiwire proportional counter. The derivation is based on the assumption that all the primary electrons are collected instantaneously by the anode and the secondary ionization takes place in the immediate neighborhood of the wire. The output pulse is thus assumed to be determined exclusively by the motion of the positive ions and each pulse will have the same shape regardless of the location of the primary ionization. (W.H.K.)

9642 (UCRL–19364) ENERGY AND FLUX DETERMINATIONS OF HIGH-ENERGY NUCLEONS. Wollenberg, Harold A.; Smith, Alan R. (California Univ., Berkeley. Lawrence Radiation Lab.). Aug 1969. Contract W-7405-eng-48. 12p. (CONF-691101–12). Dep. CFSTI.

From International Conference on Accelerator Dosimetry and Experience, Stanford, Calif.

The fission track method is used to determine the energy and flux of neutrons and protons in the energy range above 50 to 100 MeV. Foils of U, Bi, Au, and Ta together with muscovite mica track detectors are exposed to nucleons of unknown high energy and flux. The effective energy of these nucleons is determined by comparing ratios of fission track densities of various targets (the ratios U/Au, U/Ta, and Bi/Au, for example) with calibration curves of energy versus track-density ratio. Knowing the effective energy, one can then select the appropriate cross section from experimentally determined cross-section curves, and can then determine an effective nucleon flux for the exposure conditions. This technique was tested using data from an experiment at the CERN P. S.; results were in good agreement with those from measurements of ^{11}C activity in plastic scintillators exposed under the same conditions. (auth)

9643 NEW DESIGNS OF TRANSISTORIZED RADIOMETERS. Kalisz, J. Przegl. Elektron.; No. 7, 313-24(1966). (In Polish).

Three types of Polish made transistorized radiometers used for dosimetric and industrial purposes are described. These are: 1) popular radiometer type RK-64 using as radiation detector a type STS-5 Geiger–Mueller counter; 2) type TOM 201 universal radiometer for measuring surface alpha contamination, gamma radiation, neutrons etc.; 3) type TOM 202 universal radiometer of more up-to-date design and easier to operate than the former. The electronic systems of these radiometers are so designed that they do not require a special selection of components provided that they comply with normal technical requirements. Special requirements are imposed only on electrolytic capacitors in integrating circuits the leakage current of which should be very small. All radiometers are made with the use of Polish made components except for radiation detectors. From the point of view of electronic design, the radiometers meet the requirements for dependability and stability of the operating parameters. They are insensitive to vibrations. Their power consumption is low and they are easy to operate. The design and operation of each radiometer are described, and schematic diagrams with technical specification of the components are included. (Polish Tech. Abstr.)

9644 THE DEVELOPMENT AND ANALYSIS OF A COMPUTER METHOD FOR THE INTERPRETATION OF RADIOISOTOPE DISTRIBUTION PATTERNS. Sprawls, Perry Jr. Clemson S. C.; Clemson Univ. (1968). 107p.

Thesis.

A computer oriented procedure is developed which separates radioisotope thyroid scans into clinical classifications of either normal or abnormal. The distribution pattern is translated into an 18-dimensional vector by computing 18 different parameters which describe the shape of the distribution pattern. The distribution of radioactivity along both the horizontal and vertical axes through the organ is considered. For each distribution profile, the dispersion, skewness, and kurtosis are computed. These computations are performed for the total thyroid gland and then for the right and left lobes. These 18 quantities constitute the components of the vector used to represent the radioisotope distribution pattern. The relationship of these parameters to the development of four different pathological conditions of the thyroid gland has been studied. A group of normal patterns has been analyzed to determine the range of the 18 parameters for thyroid glands in which pathological conditions were absent. To permit instantaneous display of a pattern being processed by a computer, a special display program was developed for a small laboratory-type computer with the capability for analog output which utilizes a standard character generation program. The patterns for 60 different patients were selected for processing through the computer interpretation system. The interpretations agreed in 57 out of the 60 cases. (TSS) (Diss. Abstr.)

9645 GAMMA CANCELLATION TECHNIQUE: A NEW APPROACH TO THE GAMMA-FLASH PROBLEM. Gozani, T.; Ginaven, R. O. (Gulf General Atomic Inc., San Diego, Calif.). Contract AT(04-3)-167. Nucl. Instrum. Methods; 76: 333-6 (1969).

A simple and efficient method of obtaining fast recovery of neutron detectors subject to high transient gamma fields has been developed. The method, based on the subtraction of coincident pulses from pairs of identical detectors, has been shown to perform very well for BF_3 tubes used to detect neutrons following the gamma flash from an electron linear accelerator. (auth)

9646 PERFORMANCE OF A Ge(Li)-DETECTOR IN HIGH MAGNETIC FIELDS. Ganner, P.; Rauch, H. (Oesterreichische Hochschule, Vienna). Nucl. Instrum. Methods; 76: 295-300(1969).

An encapsulated Ge(Li)-γ-detector (2 cm^3 of active volume) has been placed into a strong magnetic field of a superconducting magnet (up to 60 kOe) and its effect on energy resolution and full energy peak efficiency was measured in the energy range from 40 to 1333 keV at 6 different detector bias voltages. The fwhm was found to be increased by increasing magnetic field and decreasing bias voltage. The full energy peak efficiency was sharply decreasing in the field. A cryostat system was constructed for operating the Ge(Li)-γ-detector in the field of the superconducting magnet. A brief phenomenological explanation of the measured results is given. (auth)

9647 FINITE SOLID-ANGLE CORRECTIONS FOR Ge(Li) DETECTORS. Camp, D. C.; Van Lehn, A. L. (Univ. of California, Livermore). Nucl. Instrum. Methods; 76: 192-240 (1969).

Finite solid-angle corrections have been calculated for Ge(Li) detectors. Planar detectors considered vary from 4 to 20 cm^2 and from 6 to 16 mm in depletion depth. True circular coaxial detectors vary from 26 to 50 mm in diameter with depletion depths from 7 to 20 mm and lengths from 22 to 57 mm. Five-sided detectors of both trapezoidal and circular cross sections are included, and these range from 20 to 70 mm in length and from 8 to 20 mm in depletion depths. The corrections are calculated for source distances of 3.0, 5.0, 7.0 and 10.0 cm. Results are presented in tables rather than as graphs for greater accuracy. Interpolation is easy and accurate for configurations and distances other than those given. Finite size sources cause small reductions in the point source corrections. Graphs and formulas are presented which allow the reductions to be calculated for spherical or cylindrical sources. (auth)

9648 A SCINTILLATION PROBE FOR EFFICIENT COUNTING OF LOW ENERGY BETA RAYS IN THE ELUTION FROM LIQUID OR GAS CHROMATOGRAPHS. Shigematsu, A.; Toyohara, M.; Tomano, K. (Research Inst. of Tuberculosis, Tokyo). Nucl. Instrum. Methods; 76: 301-4(1969).

A counting system is described for the continuous scanning of soft beta ray emitters in the eluate from liquid or gas chromatographic columns. A relatively small portion of the column stream is diverted through the counting system while the main portion is passed through a light absorbance measurement and recording device to a fraction collector. The stream to be counted is mixed with liquid scintillator by cavitation and then nebulized into the counting chamber using a suitable gas to give a counting efficiency equivalent to that of vial counting. Radioactive counts and absorbance measurements can be plotted simultaneously on a chart recorder. The convenience and efficiency of the system was demonstrated by the recording of the counting and absorbance data for an aqueous elution of s-RNA, DNA and DNA-like RNA from a methylated albumin column. (auth)

9649 DYNAMICS OF THE CONTINUOUS FLOW MANGANESE BATH SYSTEM. Beynon, T. D.; Scott, M. C. (Univ. of Birmingham, Eng.). Nucl. Instrum. Methods; 76: 328-32(1969).

Exact and approximate solutions of the equation governing the activity growth in continuously cycled assemblies are presented. These solutions are applied to manganese and vanadium systems of practical interest and the implications for neutron yield measurements are discussed. (auth)

9650 CONTINUOUS GAMMA MONITOR (July 26, 1968) (Engineering Materials). (Richland Operations Office (AEC), Wash.). (CAPE–1947).

4 drawings.

A continuous gamma monitor which is installed on a waste

stream receiving tank in a solvent extraction battery in the Plutonium Reclamation Facility at Hanford is described. A NaI crystal, an EMI 9536 B phototube, and a preamplifier are fitted in a 3 in. schedule 40 pipe. Lead wrapping and Pb wool are used for shielding. The sampler, used with the monitor, is located in a Kynar enclosure. (For details see TID-4100 Suppl. 56.) (F.S.)

9651 SURFACE BARRIER LITHIUM DRIFTED SILICON DETECTOR WITH EVAPORATED GUARD RING. Belcarz, E.; Chwaszczewska, J.; Slapa, M.; Szymczak, M.; Tys, J. (Inst. of Nuclear Research, Swierk, Poland). Nucl. Instrum. Methods; 77: 21-8(1970).

Lithium drifted silicon planar detectors with surface barrier provided with evaporated gold guard ring have been prepared. It has been found that the resistivity of the gap between central electrode and guard ring is comparable with the resistivity obtained in detectors with engraved guard rings. Application of such guard rings make the work at the detector bias voltage of the order of 300 V/mm feasible, reduces considerably the reverse currents and enables to define precisely the geometrical active region of the detector. The energy resolution obtained for this type detectors with active area of 0.7 cm^2 and thickness of 2.4 mm is 1.26 keV for 14.4 keV gamma radiation and 3.1 keV for 976 keV internal conversion electrons. (auth)

9652 A SYSTEM FOR STABILIZING THE EFFICIENCY OF SCINTILLATION DETECTORS WITH WEAK PHOTOCATHODE ILLUMINATION. Hewitt, J. S.; Walker, J. (Univ. of Birmingham, Eng.). Nucl. Instrum. Methods; 77: 112-24(1970).

A system for stabilizing the effective bias level in a large class of scintillation detectors to within 0.1% is described in detail. The system, which encompasses all drift-prone components in the feed-back loop, including the operating discriminator, employs a stable pulsed light source to generate the reference line in the scintillation spectrum. Thermistors driven by binary signals provide the highly stable feed-back coupling which is essential when the reference line is severely broadened due to photoelectron fluctuations accompanying weak photocathode illumination. This requirement is given a quantitative basis in the control theory presented. The analysis also permits the prediction of the stabilization factor, stabilization rate, and statistical fluctuations for different detectors to which the stabilizer may be coupled. The analytical results may also describe other stabilizers obeying proportional control theory, including proportional control spectrometer stabilizers. (auth)

9653 THE NUCLEAR PARTICLE DETECTION SYSTEM (NPDS): A PROTON-ALPHA PARTICLE COUNTER FOR THE APOLLO SYSTEM. Hubbard, E. L. (Philco-Ford Space and Reentry Systems, Palo Alto, Calif.); Petroka, E. L.; McMorrow, D. R.; Kramer, B. R. Nucl. Instrum. Methods; 77: 125-35 (1970).

The Nuclear Particle Detection System (NPDS) is a charged particle counter designed to measure solar flare protons, and alphas incident on the Apollo spacecraft. The instrument detects protons in four differential energy intervals between 10 and 170 MeV, alphas in three differential energy intervals between 42 and 318 MeV. It also integrates all protons with energy ≥15 MeV. The instrument consists of two major components: (i) the detector telescope and (ii) the signal analyzer. The detector telescope employs three solid state detectors and has three charge sensitive preamplifiers in it. The signal analyzer contains primarily six post amplifiers, sixteen level sensors, a logic module a dc to dc converter and eight ratemeters as outputs. The instrument works in both an E and dE/dx mode to produce a "cusp" in the response curve of each detector to incident protons and alphas. The setting of the level sensors together with the proper range to the front of each detector and the system logic determines the energy intervals of protons and alphas detected. A total of twenty-three instruments have been produced and one will be flown on each Apollo mission starting with Apollo 8. The total system operation is discussed. (auth)

9654 DETECTOR FOR TRITIUM IN WATER. Osborne, R. V. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Nucl. Instrum. Methods; 77: 170-2(1970).

A cell containing a stack of plastic scintillator sheets measures concentrations of tritium in water down to 1 μC $liter^{-1}$. The response time constant is less than one minute. (auth)

9655 AUTOMATIC COMPENSATION OF DEADTIME LOSSES. Taylor, D.; Blatt, S. J.; Henderson, I. A. (Univ. of Strathclyde, Glasgow). Nucl. Instrum. Methods; 77: 177-8(1970).

Alternative digital methods are discussed for the automatic compensation of deadtime losses, particularly those making use of universal counters, and thereby reducing the amount of equipment needing to be specially made. (auth)

9656 AN EXACT CALCULATION OF TIME RESOLUTION WITH THE SCINTILLATION DETECTOR. Donati, S.; Gatti, E.; Svelto, V. (Laboratori CISE, Milan). Nucl. Instrum. Methods; 77: 179-80(1970).

Starting from the results of a statistical analysis, the time resolution of a model of the scintillation detector is computed exactly. The accuracy of the well-known approximated expression has been checked. (auth)

9657 ALPHA PARTICLE RECORDING WITH THE USE OF CELLULOSE ACETATE. Cervasek, J. (Inst. of Nuclear Research, Rez, Czech.). Jad. Energ.; 15: 413-15(Dec 1969). (In Czech).

Experiments carried out in the reactor indicated the ORWO cellulose acetate foils to be a convenient detector for registering 1.5 MeV alpha particles in the environment of gamma radiation and thermal neutrons, and at the temperatures of about 100°C. The 60 minutes of etching in the concentrated (20) solution of KOH at the temperature of 50 to 60°C proved to be satisfactory for the visibility of particle traces. This method has been used for the identification of boron phase in steel on the base of the $^{10}B(n,\alpha)^{7}Li$ nuclear reaction. The relative short exposure intervals and the temperature of 100°C showed no substantial recovery of the traces. (auth)

9658 REVIEW OF NEUTRON DETECTION METHODS IN VIEW OF 25 keV NEUTRON MONITORING. Kadlec, Vladimir (Inst. of Nuclear Research, Rez, Czech.). Jad. Energ.; 15: 404-10(Dec 1969). (In Czech).

The possibilities of ~25 keV neutron monitoring are reviewed. The detection of neutrons at this energy region is important mainly in shielding problems as the group of 25 keV neutrons predominates in the reactor spectrum after penetration through a thick iron plate. The study of all available methods shows that for neutron monitoring at about 25 keV, the proportional H-filled counter designed as low energy detector is the most convenient one. (auth)

9659 APPARATUS AND METHOD FOR CONSTRUCTING APPARATUS FOR MEASUREMENTS OF NEUTRON FLUX. Obrowski, Walter; Schruefer, Elmar; Boernig, Karl-Heinz (to Licentia Patent-Verwaltungs-GmbH, Deutsche Gold- und Silber-Scheideanstalt vormals Roessler). U. S. Patent 3,444,373. May 13, 1969. Priority date June 16, 1964, Germany.

A neutron flux measuring device is described which consists of a sheath made of heat conducting material filled partly with a neutron-sensitive and partly with a neutron-insensitive nonelectrically conducting substance. Two thermoelements, one embedded in the neutron-sensitive substance the other in the insensitive substance, are connected either in series or parallel and measure the amount of heat produced by the interaction of neutrons with the neutron-sensitive substance. The desired degree of packing density, at least of the neutron-sensitive material, may be obtained by drawing the device through a die to decrease the diameter of the sheath. (Offic. Gaz.)

9660 NUCLEAR RADIATION DETECTION. Fioroni, Furio (CNEN, Casaccia, Italy). Com. Naz. Energ. Nucl. Notiz.; 15: No. 2, 31-42(Feb 1969). (In Italian). (RT/EL-(69)4).

In the field of radiation detection, new methods and whole new classes of detectors have recently been introduced in addition to the methods and designs already in use. Certain aspects of this evolution are presented with particular regard to the work done at the Electronics Laboratory of the Casaccia Nuclear Research Center. (auth)

9661 DOSE SENSITIVITY OF TRACK-TYPE NEUTRON DETECTORS. Obaturov, G. M. At. Energ. (USSR); 27: 470-4(Nov 1969). (In Russian).

In view of the absence of data on the neutron dose sensitivity of the track-type detectors, tests were carried out to determine this factor for detectors provided with layers of ^{237}Np, ^{238}U (230 fold depleted), natural U and ^{235}U (90% enriched) toward $0.5 < E < 10$ MeV monoenergetic neutrons. Similar mean dose sensitivity measurements were made for 12 different neutron spectra, ranging from soft to very hard—the fission spectrum. It was found that the dose sensitivity is strongly dependent on the neutron energy; however, for ^{238}U, and natural U detectors and neutrons with energies higher than 1.5 MeV, and ^{237}Np detectors for neutrons with $E > 0.6$ MeV, the sensitivity changes only slightly and remains within the (1.38 to 1.93) and (3.34 to 5.93) $\times 10^2$ tracks/rad. cm^2, with a maximum deviation of ±16 and ±28% from the mean value. A formula was derived to calculate the tissue and the equivalent kerma for a given energy range. The natural U and ^{235}U type detectors cannot be used for the estimation of the kerma in any neutron energy range. (TTT)

9662 PLASTIC SCINTILLATORS IN NUCLEAR MEASURING TECHNIQUES. Maier, H. J.; Kretz, R. (Roehm and Haas GmbH,

Darmstadt, Ger.). Messtechnik; 77: 255-63(Nov 1969). (In German).

A survey on plastic scintillators is given. Their composition, a theory of operation and their man experimental properties are described. The response to charged particles, neutrons and γ-rays is discussed. Finally, a few examples of application are cited. (auth)

9663 IMPROVEMENTS IN OR RELATING TO ION CHAMBERS. Rhodes, John Rathbone (to United Kingdom Atomic Energy Authority). British Patent 1,173,155. 3 Dec 1969. Filed 8 Sep 1966.

Reference is made to measuring heads which include a differential ion chamber. The instrument described has positively and negatively charged electrodes, together with a central collecting electrode. A front window gives access to the electrode spaces. A pair of balanced differential filters is provided, one filter being associated with each half of the window. A shield covers the central position of the window and has one or more sources mounted on the side remote from the window. A back window may also be provided which is transparent to an unwanted high energy component of the radiation backscattered from a target. The apparatus is designed for backscattering geometry only. It discriminates against all radiation except that Kα due to the wanted element in the target. The use of an extended source shield is advantageous in that it improves the tolerance to variations in source-to-target distance. (UK)

9664 THE INTERFACE AND ON-LINE OPERATION OF A SCINTISCANNER WITH A DIGITAL COMPUTER. PART I. HARDWARE. Eisenhauer, P.; Habermehl A.; Joseph, K.; Graul, E. H. (Philips-Univ., Marburg, Ger.). Meth. Inform. Med.; 8: 127-33 (Jul 1969). (In German).

A digital computer was used to store and process the radioisotope count information recorded by a scintiscanner. The main equipment consisted of a Picker Magnascanner and a PDP 8/S computer. A teletypewriter, an oscilloscope, and an X-Y plotter were used as output devices. The interface electronics transferred the scanner information to the computer and controlled the output devices from the computer program. The transfer interface unit contained a counter. The combined use of this counter and the program interrupt ensured that only a small percentage of the computer's time was required during the recording of the scintiscanner. The remainder of the time was used to process the data matrix of a scan or for the services of other laboratory equipment. The storage interface is discussed and its operation is illustrated. The general operation of the equipment, including scanner, computer, input-output devices, and the procedure for production of a processed scan, are described. The computer program is discussed briefly. (BBB)

9665 DETERMINATION OF ^{14}C IN SUGI SEEDLING BY LIQUID SCINTILLATION COUNTER (LSC-502). Sakagami, Yukio; Anma, Yoshiteru (Government Forest Experiment Station, Tokyo). Nippon Ringaku Kaishi; 51: 161-3(1969). (In Japanese).

The liquid scintillation counter, whose counting efficiency is extremely high in comparison with other counters, is indispensable for the measuring of the mild β ray. The conditions for the measurement of ^{14}C and ^{3}H by LSC-502 were examined. The sample to be measured was divided into groups to which hiamin was added and not added. 15 ml of each liquid scintillator, 1 ml of the standard solution and 1 ml of hiamin were poured into a 20 ml container, shaken, kept in the counter for 12 hours and then the count rate was determined every 10 minutes. The investigations were performed for the volume quenching (amount and counting efficiency of the liquid scintillator), the quenching by oxygen and the fading-away time of the afterglow caused by exposure. For the determination of ^{14}C in the dried and finely powdered Sugi seedling by the liquid scintillation counter, approximately 10 mg of the sample was oxidized by the wet process of the Van Slyke–Folch method, and absorbed by 10 ml of 0.25 N $Ba(OH)_2$ being shaken in ice water for one and a half hours. $^{14}CO_2$ generated by 5 ml of 2N HCl was absorbed by 10 ml of the liquid scintillator added by 1 ml of hiamin. This liquid scintillator was transferred into the sample container, and the measurement was carried out after setting it in the counter and leaving it for 6 hours. The variation coefficient of the values thus obtained was 3.5%. But, as the variation coefficient of the determined values of $^{14}CO_2$ generated from Ba $^{14}CO_3$ and absorbed by the above mentioned method was 0.3%, this 3.5% was considered to be some sampling error caused by two large a diameter of the particles of the sample. (NSA of Japan)

Nuclear Spectroscopic Instrumentation

Refer also to abstracts 9640, 10610, and 11252.

9666 (BARC–412) INSTRUCTION MANUAL FOR THE CONSTANT VELOCITY REVOLVING ABSORBER MOESSBAUER SPECTROMETER. Nathan, P. S. P. (Bhabha Atomic Research Centre, Bombay (India)). 1969. 12p. Dep. CFSTI (U. S. Sales Only).

The operational and functional details of the constant velocity revolving absorber Moessbauer spectrometer, designed and developed at the Nuclear Physics Division of the Bhabha Atomic Research Centre, are described. (auth)

9667 (BNWL–1227) GSSLRN-I: AN AUTOMATED LEAST-SQUARES COMPUTER CODE FOR THE ANALYSIS OF PHOTOPEAK SPECTRA. Seybold, G. D. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Nov 1969. Contract AT(45-1)-1830. 50p. Dep. CFSTI.

A computer code, GSSLRN-I, is presented which is utilized for evaluations and statistical determination of photopeaks in photon spectra. The code performs evaluations of photopeak spectra using as input the digitized pulse height distribution which is output from a large multichannel analyzer. Photopeaks are located, functions are fit to each real peak, and the relative intensity of each fitted peak above the background continuum is calculated. The code contains various execution options and allows the user to obtain automatic and detailed plotting of the data and the results of each fit. The code is easily adaptable for analysis of any spectra which can be adequately defined by peaks represented in analytic form. Thus, it should be useful for application in such areas as; radiochemical analysis, analysis of reactor fuel burnup, half-life determinations, geological evaluations with respect to mineral content or time periods, analysis of Moessbauer spectra and determination of elements in blood or body tissue. (auth)

9668 (ORNL-tr–1861) THE RELATIVE STOPPING POWER OF SOME SUBSTANCES FOR α PARTICLES UP TO 5 MeV. Fiedler, O.; Ulrich, D. Translated by R. Gregg Mansfield (Oak Ridge National Lab., Tenn.), from Z. Phys.; 200: 493-8(1967). 6p. Dep. CFSTI.

The stopping power for α-particles of 0.3 to 5 MeV relative to air and hydrogen is determined experimentally for aluminum, silver and gold, as well as for varnish and paraffin. In the region of validity of the Bethe–Bloch theory the measured values agree well with the calculated ones. The relative stopping power is calculated by the Bragg law for α-particles of 5 MeV for the organic substances varnish, paraffin, mylar and formvar. The values for varnish and paraffin agree approximately with these. Previous measured values for varnish and formvar deviate from these. (auth)

9669 (UCRL–18948) COMPUTER ANALYSIS OF SPECTRA. Lederer, C. Michael (California Univ., Berkeley. Lawrence Radiation Lab.). Sep 1969. Contract W-7405-eng-48. 55p. (CONF-690818–9). Dep. CFSTI.

From International Conference on Radioactivity in Nuclear Spectroscopy, Nashville, Tenn.

Computers have contributed greatly to automation in the analysis of multichannel spectra and, more importantly, to the accuracies which can be achieved. The fundamental part of most spectral analysis methods—peak-shape analysis—is reviewed with emphasis on the present and potential level of accuracy in the determination of energies and intensities. The methods are illustrated with analyses of Ge(Li) gamma-ray spectra, although the techniques are quite general for high-resolution, multichannel spectra. It is found that gamma-ray energies can be determined to a few eV if suitable standards are available. Measurement of intensities to better than the present best error level of 1 to 2% seems possible. The resolution of closely spaced multiplets can be done far more accurately than by graphical techniques. Less basic problems pertaining to specific applications, such as automatic peak identification and grouping of peaks for fitting, are discussed less critically; some examples of programs in current use are given as illustrations. (auth)

9670 (UCRL-Trans–10421) CRYSTAL SPECTROMETER FOR POLARIZED NEUTRONS. Beil, H.; Carlos, P.; Genin, R.; Signarbieux, C.; Joly, R.; Matuszek, J. Translated by W. G. Robinson for Lawrence Radiation Lab., Livermore, Calif., from J. Phys. (Paris), 24: Suppl. to No. 6; 89A-93A(Jun 1963). 17p. Dep. CFSTI.

A description of a crystal spectrometer which produces a monochromatic polarized neutron beam is presented. Some preliminary results of a study made on such polarized beams in the energy range from a few milli-electronvolts to a few electronvolts are also given. (auth)

9671 THE EFFECTS OF CARRIER TRAPPING IN SEMICONDUCTOR GAMMA-RAY SPECTROMETERS. Trammell, R.; Walter, F. J. (ORTEC Inc., Oak Ridge, Tenn.). Nucl. Instrum. Methods; 76: 317-21(1969).

Currently accepted theories predicting the effects of carrier trapping on the spectrum from semiconductor gamma-ray spectrometers are reviewed. The physical models used in these theories are re-examined and a new theory is presented which predicts quite different effects. (auth)

9672 SIMPLE AND ACCURATE CALIBRATION TECHNIQUE FOR MEASURING γ-RAY ENERGIES AND Ge(Li) DETECTOR LINEARITY. Strauss, M. G.; Lenkszus, F. R.; Eichholz, J. J. (Argonne National Lab., Ill.). Nucl. Instrum. Methods; 76: 285-94(1969).

A technique for precise calibration of Ge(Li) γ-ray spectrometers, which is particularly useful in studies of decay schemes, has been developed. The differential response of a multichannel analyzer is measured with a sliding pulse generator whose incremental nonlinearity is 0.005–0.01%. The integral of this response with respect to counts is a linear function of energy. With the use of two known γ-ray lines the calibration constant in counts/keV, and in turn, the energies corresponding to unknown γ-ray peaks can be determined. The technique is simple, fast and virtually automatic. The method was evaluated by measuring γ-ray energies (0.27–2.75 MeV) from ten sources. The results obtained agree with published values to within the measurement uncertainty of 40–110 eV. The accuracy of the technique depends on the linearity of the sliding pulser and the Ge(Li) detector. From a spectrum of ^{66}Ga, measured energy intervals of $2m_0c^2$ were examined as a function of γ ray energy. The standard deviation of the eight $2m_0c^2$ intervals was only 0.08 keV. It is therefore concluded that between 1 and 5 MeV the incremental non-linearity of the coaxial Ge(Li) detector is less than ±0.1 keV. Measurement uncertainties due to errors in the calibration standards, peak location, and the number of counts/channel in the differential response are discussed. (auth)

9673 A WELL-TYPE Ge(Li) DETECTOR FOR SUM-COINCIDENCE STUDIES. Santhanam, S.; Monaro, S. (Univ. of Montreal). Nucl. Instrum. Methods; 76: 322-7(1969).

The feasibility and usefulness of a coaxial Ge(Li) spectrometer as a well-type detector for sum spectra of coincident gamma rays are demonstrated. The value of the well-type geometry has previously been established in nuclear gamma spectroscopy with the use of NaI(Tl) detectors. In this work a 16 cm^3 hollow cylindrical germanium detector has been made and mounted in such a way that access to the center of the detector is achieved from outside the cryostat. The detector is a fully depleted structure in which a hole of 1 cm diameter was ultrasonically cut, and a non-injecting contact applied to the inside surface. The detection of sum lines arising from 2 or more coincident gamma rays is demonstrated by using the radioactive sources of ^{110m}Ag and ^{110m}In. With the source inside the well, for which the counting solid angle is nearly 4π, the sum peaks of two or three lines were observed with an energy resolution of 3.5 keV (fwhm). For the source outside the detector at a distance of 10 cm, these sum lines were not observed above background for comparable counting statistics. Although the efficiency of the Ge(Li) spectrometer is not as high as that of the NaI(Tl), it is shown that this limitation is more than offset by its superior resolution. (auth)

9674 ESTIMATION OF SPECTRA FROM EXPERIMENTAL DISTRIBUTIONS. Green, D. W. (Univ. of Calgary, Alberta). Nucl. Instrum. Methods; 76: 349-56(1969).

The problem of estimating physical spectra from experimental pulse-height distributions is analyzed by means of Fourier transform techniques. After the existence of optimum numbers of degrees of freedom to be assigned to the input data and the spectral estimate is established, the problem is reformulated in terms of the Fourier transform of the input data. The estimation of stable, smoothed spectra from real, statistical data then become a computationally simple procedure requiring no a priori spectral information. Several examples are given. (auth)

9675 DEVELOPMENT, CALIBRATION, AND UTILIZATION OF THE KSU NE-213 FAST-NEUTRON SPECTROMETER. Simons, Gale Gene. Manhattan, Kan.; Kansas State Univ. (1969). 205p.

Thesis.

A fast-neutron spectrometer using a liquid organic scintillator solution, NE-213, a modified Forte gamma ray discrimination circuit and associated electronics consisting primarily of solid state AEC standard, NIM, modules was developed, calibrated and used to measure fast-neutron spectra. The absolute efficiency of the complete spectrometer (with a 1.82 × 2.03 inch diameter NE-213 detector and gamma ray discrimination ratio set at 150:1) was experimentally measured over the neutron energy range 1.0 to 9.0 MeV using the LASL 8 MeV vertical Van de Graaff and the LASL recoil proton telescope. Twenty-two nearly monoenergetic response functions were also measured and normalized on an absolute flux basis using the measured efficiencies. Plots and tabulations of these 22 normalized response functions are included. A stepwise multiple regression unfolding code, NEUSTEP, was developed and used to unfold polyenergetic fast-neutron source spectra for PuBe, AmBe and Cf-252 packaged neutron sources and both direct and reflected TRIGA reactor collimated fast beam port spectra. NEUSTEP unfolded spectra were compared with nuclear emulsion results where available and results obtained with the ORNL unfolding code FERDOR. Thermal fission source neutrons were reflected from thick slabs of concrete and iron and the reflected spectra were measured for various combinations of incident polar and reflected polar and azimuthal angles. The concrete results unfolded with both the NEUSTEP and FERDOR codes were compared to ORNL Monte Carlo calculations for concrete. (Diss. Abstr.)

9676 A METHOD FOR CORRECTING THE TIME-OF-FLIGHT SPECTRA FOR THE NEUTRON EMISSION TIME AND THE DETECTOR EFFICIENCY. D'Oultremont, P. (Gulf General Atomic Inc., San Diego, Calif.). Nucl. Instrum. Methods; 77: 1-9(1970).

When one measures the spectrum of a subcritical reactor by the time-of-flight method, the recorded spectrum cannot be directly compared to the calculated steady-state spectrum of the system. Indeed, there is no simple relationship between the arrival time of a neutron at the detector and its energy since the time at which the neutron leaves the reactor is not known and the energy dependence of the detector response distorts the spectrum. A method based on the detailed computation of the response of the reactor to a narrow burst source of arbitrary spectrum has been devised. It allows the calculation of a correction factor for each channel of the time analyzer. Multiplying the time-of-flight spectrum by this correction factor provides a spectrum in the flux per unit of lethargy scale which can then be compared directly to ordinary steady-state calculations. (auth)

9677 FOURIER ANALYSIS OF THERMAL NEUTRON TIME-OF-FLIGHT DATA: A HIGH EFFICIENCY NEUTRON CHOPPING SYSTEM. II. Colwell, J. F.; Lehinan, S. R.; Miller, P. H. Jr.; Whittemore, W. L. (Gulf General Atomic Inc., San Diego, Calif.). Nucl. Instrum. Methods; 77: 29-39(1970).

Additional methods for obtaining Fourier components of time-of-flight spectra digital phase-sensitive measurements are presented. The Fourier chopper system is extended to measurement of the scattering kernel using two phased choppers. Filters to tailor the shape of the time-of-flight spectra recovered from the analysis are presented. Measurement via Fourier components allows one to concentrate on that frequency range which contains the information of most interest. This capability would be useful in measuring the diffusion broadening of quasi-elastic scattering peaks in liquids and in measuring resonances in the total cross section. (auth)

9678 ANALYSIS OF LINEAR POLARIZATION MEASUREMENTS OF UNRESOLVED GAMMA RAYS. Taras, P.; Matas, J. (Univ. of Montreal). Nucl. Instrum. Methods; 77: 10-12(1970).

An analytical method which makes it possible to interpret the data from a linear polarization measurement of two unresolved γ-rays is presented. The method is applied to two partially resolved γ-rays in ^{35}Cl. (auth)

9679 ON-LINE COMPUTER-CONTROLLED TRIPLE-AXIS NEUTRON SPECTROMETERS AT THE HFIR. Wilkinson, M. K.; Smith, H. G.; Koehler, W. C.; Nicklow, R. M.; Moon, R. M. (Oak Ridge National Lab., Tenn.). pp 253-8 of Neutron Inelastic Scattering. Vol. II. Vienna; International Atomic Energy Agency (1968).

From Symposium on Inelastic Neutron Scattering, Copenhagen, Denmark. See STI/PUB-187(Vol.2); CONF-680501-(Vol.2).

Two computer-controlled triple-axis neutron spectrometers have been constructed and installed at horizontal beam ports of the High Flux Isotope Reactor (HFIR). These spectrometers have been designed to provide maximum flexibility for use in many different types of investigations. The monochromator cavity contains both a polarizing and a non-polarizing crystal, and since either crystal can be selected and accurately positioned by external controls, the spectrometers can be modified relatively quickly for experiments requiring either polarized or unpolarized neutrons. Each spectrometer is controlled on-line by its own computer, a Programmed Data Processor-8 (PDP-8), through pulsed motors that drive up to six spectrometer axes. The advantages of this system lie in the flexibility of experiment control by stored programs on magnetic tape, which are brought into the fast memory when the conditions of the experiment dictate it. In addition to controlling the spectrometer, each computer has interfacing that allows control of auxiliary equipment such as

shutters, velocity selectors, electromagnets, strip-chart recorders, and temperature controllers. (auth)

9680 MCMASTER UNIVERSITY NEUTRON CRYSTAL SPECTROMETERS. Brockhouse, B. N.; deWit, G. A.; Hallman, E. D.; Rowe, J. M. (McMaster Univ., Hamilton, Ont.). pp 259-70 of Neutron Inelastic Scattering. Vol. II. Vienna; International Atomic Energy Agency (1968).

From Symposium on Inelastic Neutron Scattering, Copenhagen, Denmark. See STI/PUB-187(Vol.2); CONF-680501-(Vol.2).

Three crystal spectrometers of unusual and differing designs have been constructed over the past five years. The angular ranges of most variables extend upwards of 145°. Extensive use is made of commercial machinists' rotary tables. Analyzing spectrometers employ two side-irradiated helium-3 counters mounted on arms ~15 cm in length which move within cylindrical shielding. One counter records signal, the other background. Crystals are copper slabs, normally used in reflection from (200) or (220) planes. The mosaic spreads were increased by mechanical deformation. Extensive studies of different methods of deformation have been made; the best appears to involve repeated bending and straightening of the crystal around a vertical radius (~90 cm) at room temperature. Improvements in reflectivity by a factor of four, and integrated reflectivities of ~10 minutes of arc have been obtained. At the McMaster University reactor, two instruments use the same original beam, one of them an unconventional multiple-axis spectrometer which offers the possibility of use of multiple analyzers. Borated water in iron tanks (protected by magnesium ingots) is used for shielding. An instrument at the NRU reactor at Chalk River employs a dual monochromator deep within the experimental hole. After double reflection from {220} planes of two parallel crystals, the monoenergetic beam emerges along its original direction. The specimen is at a position fixed in space, thus making spectrometer construction simple. Both spectrometers are fully automatic with all the usual capabilities. The control units employ IBM (0-24) card punches as card readers. Extremely simple logic permits complete non-linear control of six independent variables, in one or two analyzing spectrometers. (auth)

9681 THE CHALK RIVER ROTATING-CRYSTAL SPECTROMETER. Woods, A. D. B.; Glaser, E. A.; Cowley, R. A. (Atomic Energy of Canada Ltd., Chalk River, Ont.). pp 281-8 of Neutron Inelastic Scattering. Vol. II. Vienna; International Atomic Energy Agency (1968).

From Symposium on Inelastic Neutron Scattering, Copenhagen, Denmark. See STI/PUB-187(Vol.2); CONF-680501-(Vol.2).

The Chalk River rotating crystal spectrometer Brockhouse has been modified in several major respects. The most significant changes were (1) the replacement of the beryllium filter by a single-crystal-quartz filter to allow passage of the complete thermal spectrum, (2) the installation of a phased rotating collimator to eliminate higher order and other undesirable reflections, (3) the use of an axis of rotation of high symmetry of the rotating crystal to allow selection from a large variety of incident-neutron energies, (4) the use of a 2.5-cm diameter rotating crystal to improve resolution, (5) the replacement of the $^{10}BF_3$ neutron detectors by ^3He detectors to improve both resolution and intensity characteristics, and (6) the use of magnetic tape recording with a direct computer connection to improve the data handling. Under present operating conditions, the apparent time-of-flight width of a small-angle vanadium pattern for neutrons of incident wavelength 3.71 Å is about 36 μsec compared with 76 μsec obtained using 4.04-Å neutrons before these changes were made. (auth)

9682 THE DOUBLE-CHOPPER NEUTRON SPECTROMETER AT ISPRA. Krebs, K. (EURATOM, Ispra, Italy). pp 289-97 of Neutron Inelastic Scattering. Vol. II. Vienna; International Atomic Energy Agency (1968).

From Symposium on Inelastic Neutron Scattering, Copenhagen, Denmark. See STI/PUB-187(Vol.2); CONF-680501-(Vol.2).

The instrument consists of two-phased triple-slotted rotor discs, which are made of heavy material (K-monel) and have a diameter of 29 cm. These rotors are able to reduce fast neutron and gamma radiation to such an extent that no filters or additional rotating collimators are needed. Each rotor is coupled to a reluctance motor driving unit by means of a thin flexible steel rod. The motor shaft of each driving unit runs on oil-lubricated precision ball bearings. Rotor and driving motor are included within the same vacuum case so that no rotating seals are needed. The maximum speed was set at 22,000 rpm for a safety factor of ~2 against yield stress. The width of each curved fluted slot is 12 mm at one end, increasing linearly to 36 mm at the other end. The ac motor of the first chopper unit is fed from a frequency generator which itself is driven by a frequency-stabilized dc motor. The second chopper unit is driven by a pulsed dc-ac thyristor power converter, the pulsation frequency of which is derived from pick-up signals coming from the first unit. Thus there exists no connection at the power side between the two motors and beating problems are avoided. The phase angle between the chopper discs can be changed by shifting the control pulses coming from the first chopper. The neutron beam of the 5-MW Ispra-I reactor is collimated and can be switched off by means of steel-lead shutters. Measurements are done simultaneously at twelve angular positions using ^3He- or BF_3-counters. The analyzer system consists of a PDP-8 computer with a special 12-input time-of-flight converter. (auth)

9683 THE SPECTROMETER FOR THERMAL-NEUTRON INELASTIC SCATTERING STUDIES AT THE IBR PULSED REACTOR. Maliszewski, E. (Joint Inst. for Nuclear Research, Dubna, USSR); Nitc, V. V.; Sosnowska, Izabela; Sosnowski, J. pp 313-21 of Neutron Inelastic Scattering. Vol. II. Vienna; International Atomic Energy Agency (1968).

From Symposium on Inelastic Neutron Scattering, Copenhagen, Denmark. See STI/PUB-187(Vol.2); CONF-680501-(Vol.2).

The design of the spectrometer for studies of inelastic coherent scattering of thermal neutrons by single crystals at the IBR reactor is described. A polychromatic pulse neutron beam is scattered by a single-crystal sample and the energy of scattered neutrons is analyzed by three analyzing single crystals (for three different beams of scattered neutrons). The time-of-flight technique is used to measure the incident neutron energy. The spectrometer is adapted for simultaneous structure and lattice dynamics studies of solids. Special features of this spectrometer and its applications are discussed. (auth)

9684 A NEUTRON CRYSTAL SPECTROMETER WITH EXTREMELY HIGH ENERGY RESOLUTION. Alefeld, B.; Birr, M.; Heidemann, A. (Technische Hochschule, Munich). pp 381-6 of Neutron Inelastic Scattering. Vol. II. Vienna; International Atomic Energy Agency (1968).

From Symposium on Inelastic Neutron Scattering, Copenhagen, Denmark. See STI/PUB-187(Vol.2); CONF-680501-(Vol.2).

The spectrometer proposed by Maier-Leibnitz is described. At the end of a neutron guide tube with a total length of 35 m, the white neutron beam falls vertically on the (111) planes of a silicon single crystal. One-half of the backscattered monochromatic neutrons enters a total-reflecting conical tube of nickelled glass plates and is focused on the sample. The scattered neutrons fall vertically on the (111) planes of the silicon analyzer crystal. This analyzer is built up of about 2000 small slices of silicon which are adjusted to the inner surface of a sphere. The solid angle from the sample to the analyzer is about 1/15 of 4π. Due to the finite size of the sample and the inaccurate adjustment of the silicon analyzers, the neutrons are not ideally focused on the sample by the analyzer. A large amount of them pass beside the sample and enter a counter. The window of the counter is about 4 times larger than the sample. By Doppler-shifting or by changing the temperature of the monochromator, the energy of the monochromatic neutrons can be varied. In this way a change of neutron energy of the order of 10^{-6} to 10^{-7} eV can be measured. It is intended to measure hyperfine splitting in solids. Two-thirds of the spin-incoherent cross section is connected with nuclear spin-flip scattering of neutrons. Changes of energy of the nuclear spin are compensated by the neutron. (auth)

9685 NEUTRON SPIN-FLIP CHOPPER FOR TIME-OF-FLIGHT MEASUREMENTS. Rauch, H.; Harms, J.; Moldaschl, H. (Oesterreichische Hochschule, Vienna). pp 387-94 of Neutron Inelastic Scattering. Vol. II. Vienna; International Atomic Energy Agency (1968).

From Symposium on Inelastic Neutron Scattering, Copenhagen, Denmark. See STI/PUB-187(Vol.2); CONF-680501-(Vol.2).

It is possible to change the direction of neutron polarization with high efficiency by means of a resonance spin-flip device, when Co-Fe single crystals are used as polarizer and analyzer in a polarized neutron spectrometer. The neutron intensity reflected by the analyzer goes to a value close to zero when the spin-flip device is on. Switching the spin-flip device on and off periodically, one obtains a chopped, monochromatic and polarized neutron beam behind the analyzer. The duty cycle and the repetition rate of the neutron bursts can be determined electronically over a wide range. Therefore, considerably higher repetition rates are possible than with mechanical choppers. This is of special interest for measurements of small neutron energy changes as in the case of quasi-elastic and critical magnetic scattering. Repetition rates up to 20 kc were used, however, this value can be further increased. The duty cycle can be adjusted electronically to any value <1. For high repetition rates and favorable duty cycles this device yields a higher peak intensity and the same or an even better resolution than expensive two-chopper systems. The energy resolution is determined by the double

crystal reflection, in this case $\Delta\lambda/\lambda = 1.3\%$. Other factors (e.g., length of the resonance coil, thickness of the detector, disturbances due to the switching process, channel width of the multichannel analyzer, etc.), which influence the time resolution decrease with $\Delta t_2/T$ as the time-of-flight (T) increases. For the apparatus, Δt_2 had the value of 52 μsec. The neutron energy can be varied from about 60 MeV to 5 MeV by changing the Bragg position (and the resonance parameters). The background turned out to be favorably low as the sample was not directly in line with the reactor beam tube. (auth)

9686 TIME-OF-FLIGHT SPECTROMETER USING AN ELECTRONIC CHOPPER FOR POLARIZED SLOW NEUTRONS. Steinsvoll, O.; Virjo, A. (Institutt for Atomenergi, Kjeller, Norway). pp 395-405 of Neutron Inelastic Scattering. Vol. II. Vienna; International Atomic Energy Agency (1968).

From Symposium on Inelastic Neutron Scattering, Copenhagen, Denmark. See STI/PUB-187(Vol.2); CONF-680501-(Vol.2).

In a diffractometer for polarized slow neutrons, the neutron spin resonance method is ordinarily used for flipping the neutron polarization. By varying the magnetic field across the flipper coil, it is possible to pulse the flipping device into or out of resonance at short intervals. One then obtains a continuous beam but with short periods of reversed neutron polarization. When this beam is reflected from a crystal by a polarization-dependent scattering process (elastic or inelastic), one obtains short periods of increased neutron intensity which can be used for time-of-flight measurements of the scattered neutron energies. A time-of-flight spectrometer utilizing this principle has been built and tested on spin-wave and magneto-vibrational scattering from a single crystal of bcc iron. (auth)

9687 CORRELATION-TYPE TIME-OF-FLIGHT SPECTROMETER WITH MAGNETICALLY CHOPPED POLARIZED NEUTRON BEAM. Pal, L.; Kroo, N.; Pellionisz, P.; Szlavik, F.; Vizi, I. (Central Research Inst. for Physics, Budapest). pp 407-16 of Neutron Inelastic Scattering. Vol. II. Vienna; International Atomic Energy Agency (1968).

From Symposium on Inelastic Neutron Scattering, Copenhagen, Denmark. See STI/PUB-187(Vol.2); CONF-680501-(Vol.2).

The transfer function of a system which is the conventional time-of-flight distribution function, is proportional to the cross-correlation function involving a random signal and the response of the system to it. An experiment using this technique is described. The chopped monoenergetic, polarized neutron beam is produced by a polarizer-analyzer Co(Fe) single-crystal system with a spin-flipper between the crystals. The flipper is switched off and on, following a binary pseudo-random sequence. Pulses from the detector are stored in the first half of the memory of a conventional multichannel analyzer. At the end of the measurement the cross-correlation function is computed in a few seconds with the use of a special plug-in unit of the analyzer and stored in the form of discrete values in the second half of the memory. The neutron economy, the resolution, and the effect-to-background ratio of the correlation spectrometer are much better than in the conventional time-of-flight method. (auth)

9688 USE OF A PSEUDO-STATISTICAL CHOPPER FOR TIME-OF-FLIGHT MEASUREMENTS. Gompf, F.; Reichardt, W.; Glaeser, W.; Beckurts, K. H. (Kernforschungszentrum, Karlsruhe, Ger.). pp 417-28 of Neutron Inelastic Scattering. Vol. II. Vienna; International Atomic Energy Agency (1968).

From Symposium on Inelastic Neutron Scattering, Copenhagen, Denmark. See STI/PUB-187(Vol.2); CONF-680501-(Vol.2).

The method of pseudo-statistical pulsing has been applied only to reactor-kinetic measurements so far. Ohanian, Perez and Uhrig proposed this method for time-of-flight measurements with pulsed accelerators. Comparative studies have shown, however, that it is not possible to give general arguments in favor of either the pseudo-statistical or the conventional time-of-flight method. Which of the two methods may be preferred depends on the kind of experiment. Pseudo-statistical pulsing may be especially advantageous for scattering experiments with thermal neutrons. A description is given of a "statistical" chopper and the method of measurement with this instrument. The different influences on the accuracy of the measurements are discussed and compared to those in a conventional time-of-flight experiment. A few examples of pseudo-statistical experiments have been simulated on a computer. It is shown that a statistical chopper is advantageous for time-of-flight spectra consisting of a number of peaks which are of main interest and have amplitudes greater than the average amplitudes of the spectra. Further, the method is advantageous in all cases where the background is very high. A preliminary experimental arrangement is described. (auth)

9689 NEW HIGH-EFFICIENCY TIME-OF-FLIGHT SYSTEM. Colwell, J. F.; Miller, P. H.; Whittemore, W. L. (Gulf General Atomic Inc., San Diego, Calif.). pp 429-37 of Neutron Inelastic Scattering. Vol. II. Vienna; International Atomic Energy Agency (1968).

From Symposium on Inelastic Neutron Scattering, Copenhagen, Denmark. See STI/PUB-187(Vol.2); CONF-680501-(Vol.2).

To overcome the low efficiency with which the usual Fermi chopper time-of-flight system utilizes the available neutron source, a new system has been developed which increases the efficiency by one or more orders of magnitude in many practical cases of interest. Several experimental models have been tested successfully. The principle of the new technique is based on continuous beam modulation and depends for its success on special apparatus for the detection and manipulation of the data. In place of the singly pulsed beam produced by a Fermi chopper, a continuous train of pulses is produced by the new system. Several methods can be employed to derive the time-of-flight distribution f(t) for the scattering data. A convenient method has been to synthesize f(t) from the Fourier amplitudes and phases determined for an appropriate number of different impressed sinusoids. In another version, a chopper with progressively increasing slit and spacing widths gave results which were successfully analyzed by a standard auto-correlation technique. Traditional considerations of overlaps are no longer valid for these new modulation techniques since the overlap produced is a necessary feature of the system. Extensive analyses were performed of the relative accuracy with which the scattering pattern f(t) can be determined with the new and conventional systems. If the scattering pattern consists of a small peak in the presence of a broad distribution, the experiment has to be examined in detail to evaluate the improvement offered by the new method. For a small bump in the valley between two enormous peaks, the conventional system may be preferred. However, for the large number of experimental cases involving a number of relatively narrow peaks, the increase in accuracy in terms of signal to noise power is proportional to the ratio of duty cycles for the two chopper systems. For almost any case connected with neutron inelastic scattering, the high-efficiency chopper system offers a substantial improvement over that with the conventional Fermi system. (auth)

High Energy Physics Instrumentation

Refer also to abstracts 9711 and 9722.

9690 SHOWER EFFICIENCY OF SPARK CHAMBER AT LONG HIGH VOLTAGE PULSE DELAY. Bostandzhyan, N. Kh.; Marikyan, G. A.; Matevosyan, K. A. (Inst. of Physics, Erevan). Izv. Akad. Nauk Arm. SSR, Ser. Fiz.; 4: 46-52(1969). (In Russian).

The shower efficiency of spark chambers filled with a "specially pure" neon gas or mixed with Ne + alcohol vapor is determined. It is found that the greater the percent of alcohol vapor in the chamber, the faster the shower efficiency of the spark chamber decreases as the delay of high voltage pulse increases. This phenomenon is more noticeable after the uninterrupted work of the chamber. (auth)

9691 THE FLUCTUATIONS OF THE TRACK BRIGHTNESS IN THE STREAMER CHAMBER. Asatiani, T. L.; Gazaryan, K. A.; Zhmyrov, V. N.; Ivanov, V. A.; Nazaryan, A. A. (Inst. of Physics, Erevan). Izv. Akad. Nauk Arm. SSR, Ser. Fiz.; 4: 53-7(1969). (In Russian).

The analysis of the fluctuations of streamer track brightness is presented. It is shown that these fluctuations are mainly related to the energy-loss ionization. A method of identification of fractionally charged particles and multi-charged nuclei by counting the number of electrons on the streamer track is proposed. (auth)

9692 WIRE SPARK CHAMBERS WITH FERRITE CORE STORAGE AND TWO COORDINATE READ OUT. Galster, S.; Hartwig, G.; Klein, H.; Moritz, J.; Schmidt, K. H.; Schmidt-Parzefall, W.; Schopper, H.; Wegener, D. (Univ., Karlsruhe, Ger. Kernforschungszentrums, Karlsruhe, Ger.). Nucl. Instrum. Methods; 76: 337-41(1969).

Spark chambers with crossed wire-planes and ferrite core memories have been constructed and used in an electron-nucleon-scattering experiment at DESY. Modules containing 256 cores are connected to the grounded and high voltage wire-planes. The input and output signals of the coreboards are directly compatible with monolithic integrated circuits. Spark chamber characteristics have been measured. Spatial resolution for a wire spacing of 1 mm is ±0.20 mm and ±0.28 mm fwhm at the grounded and the high voltage electrode respectively. (auth)

9693 CONTRIBUTION TO THE THEORY OF AVALANCHES IN STREAMER CHAMBERS. Schmitt, F.; Metzger, G.; Gresser, J.; Riedinger, M.; Sutter, G. (Centre de Recherches Nucleaires, Strasbourg). Nucl. Instrum. Methods; 76: 258-72(1969). (In French).

The Raether mechanism of the spark formation is applied to a streamer chamber and discussed. This leads to a more accurate calculation of the critical number of electrons and of the avalanche and streamer dimensions. Effect of pulse rise-time, delay and shape is analyzed and leads to conclusions on the track appearance. Experimental evidence of most of the calculations is given. (auth)

9694 WIRE SPARK CHAMBER WITH FERRITE CORE READ-OUT IN A STRONG MAGNETIC FIELD. Mukhin, S.; Carlson, P. J.; Fleury, P.; Lundby, A.; Pretzl, K. P. (CERN, Geneva). Nucl. Instrum. Methods; 77: 159-62(1970).

A description is given of the design of a ferrite core memory with various types of magnetic shielding. Test results show that this type of memory can operate in a magnetic field up to 8.5 kG. It was also found that this type of memory when inserted in an iron block could operate with a magnetic field of up to 14.5 kG. (auth)

Radiation Dosimeters

Refer also to abstracts 9660, 9668, 9907, and 10214.

9695 (JINR-P16-4765) TISSUE DOSIMETRY OF RADIATIONS GENERATED BY HIGH-ENERGY ACCELERATORS. Golovachik, V. T.; Dmitrievskii, I. M.; Komochkov, M. M.; Lebedev, V. N.; Lysak, Yu. D.; Semenov, Yu. V.; Frolov, V. V.; Cherevatenko, A. P. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1969. 13p. (In Russian). Dep. CFSTI (U. S. Sales Only).

Application of spherical tissue-equivalent proportional counters for measurement of the linear energy transfer dose spectra in the scattered radiation fields of the 70 GeV proton synchrotron (IPHE) is described. Also, the tissue depth-dose distributions in the scattered radiation fields of the JINR synchrocyclotron were measured. (auth)

9696 (STI/DOC-10/90) IAEA LABORATORY ACTIVITIES. Technical Reports Series No. 90. Fifth Report. (International Atomic Energy Agency, Vienna (Austria)). Sept. 1968. 154p. IAEA $1.00. Dep.

Development and work during the year 1967 are outlined. Activities of the IAEA Laboratories at Vienna and Seibersdorf, the International Laboratory of Marine Radioactivity at Monaco, the International Center for Theoretical Physics at Trieste, and the Middle Eastern Regional Radioisotope Center for the Arab Countries at Cairo are included. Publications issued during the period are listed. (auth)

9697 IMPROVEMENTS IN OR RELATING TO RADIATION MEASURING INSTRUMENTS. Webb, Geoffrey Arthur Morton; Walker, William Neil (to Central Electricity Generating Board). British Patent 1,175,889. 1 Jan 1970. Filed 30 Aug 1967.

Reference is made to thermoluminescence dosimeters. The instrument described is portable and comprises means for heating an irradiated thermoluminescent material, integrating an electrical signal representative of the resulting re-emitted energy in the form of light output, and for providing a visible indication of the radiation dose thereby represented. It is preferred to use the appropriate thermoluminescent material in encapsulated form, thereby obviating the need to flush inert gas through the material in order to suppress spurious effects. A Curie-point controlled electrical heater is employed, allowing a compact form of heater, without the need for a large transformer. The heating temperature should be between 280° and 320°C. The heater conveniently comprises a metal block which is heated to a controlled temperature and serves to transfer heat uniformly to the thermoluminescent package. The package is optically isolated from the heater, by use of a metal shim without significantly inhibiting heat transfer. The drawer accommodating the thermoluminescent material is fitted with a switch to bring the heater into the required position, zero the integrating circuit, and energize the heater. Various alternative arrangements of the instrument and its electronics are described. (UK)

Radiometric Instruments

Refer also to abstract 9668.

9698 (ORO-3842-1) RADIOISOTOPE X-RAY METHODS FOR FIELD ANALYSIS OF WET CONCRETE QUALITY. PHASE I. METHODOLOGY AND CONCEPTUAL INSTRUMENT DESIGN. Berry, P. F.; Furuta, T. (Nuclear-Chicago Corp., Austin, Tex. Texas Nuclear Div.). 17 Apr 1969. Contract AT(40-1)-3842. 66p. Dep. CFSTI.

A study of radioisotope X-ray methods of analysis of wet concrete quality, concerning the technical feasibility of methods of cement analysis based on X-ray fluorescence and X- or low energy γ-ray scattering is described. The results of experiments on typical concrete mixes are presented to illustrate the analytical sensitivity and also the influence of aggregate type and particle size, water content, and air entrainment resin on the measurement. A technique using low energy γ-ray scattering with the source and detector arranged in cylindrical co-axial geometry is shown to have the most promise and justify further investigation. A theoretical treatment of this geometrical arrangement is given and is shown to be in good agreement with results obtained so far. With the aid of the theoretical model, the conceptual design of a portable, self-contained analytical instrument is developed. The instrument is relatively insensitive to water content per se and incorporates a means of compensation for bulk density variation as a result of air entrainment and other variables of the concrete mix. (auth)

9699 (RISO-M-980) PROBLEMS CONNECTED WITH THE USE OF SUBSURFACE NEUTRON MOISTURE GAUGES AND THEIR SOLUTION. Oelgaard, P. L. (Danish Atomic Energy Commission, Risoe. Research Establishment). Nov 1969. 20p. Dep. CFSTI (U. S. Sales Only).

Subsurface neutron moisture gages are used in a number of different fields. In order to obtain accurate results with a given gage it is necessary to take into account a number of factors, the most important of which are the dry-bulk density of the medium, its chemical composition, its geometry, e.g., finite or infinite, and the perturbation introduced by the insertion of the access tube. A short review of the physical principles of the neutron moisture gage is given, and it is discussed what can be done to take into account the factors mentioned, in particular by the use of theoretical methods. (Denmark)

9700 APPLICATION OF THE ISOTOPE INSTRUMENTS FOR MEASUREMENT OF SNOW DENSITIES. Muraki, Yoshio; Nohara, Takio (Civil Engineering Research Inst., Sapporo). Hokkaido Kaihatsu-Kyoku Doboku Shikenjo Geppo; No. 191, 1-9(Apr 1969). (In Japanese).

Recently, the need for immediate measurement of snow densities is large, concerning removal of snow on roads, snow quality in skiing courses, and preparation of on-snow parking lots. In this connection, experiments were made on the applicability of the ordinary isotope instruments used to measure the density of soils and their moisture content, i.e., the gamma-ray densimeter and neutron moisture-meter. It was found that the gamma-ray densimeter and the neutron moisture-meter are both effective for measurement of snow densities; however, the neutron moisture meter is more convenient and practical than the gamma-ray densimeter. The following are described: preparation of calibration curve; calibration curves for the gamma-ray densimeter and the neutron moisture-meter of both surface and insertion types; sensitive regions; and examples of measurement including by-foot hardening of snow, vertical density distributions of natural snow and artificial snow, change due to time lapse in internal density of natural snow, and change due to time lapse of internal snow density due to a load. (NSA of Japan)

9701 A MONTE CARLO SIMULATION OF THE SURFACE-TYPE NEUTRON MOISTURE GAUGE. Lippold, W. J.; Carnesale, A.; Gardner, R. P. (North Carolina State Univ., Raleigh). Nucl. Eng. Design; 10: 373-80(Jul 1969).

The surface-type neutron moisture gage has been simulated with a modified version of the 05R Monte Carlo code available from the Radiation Shielding Information Center at Oak Ridge, Tennessee. Results were obtained for 19 different sample media representative of a range of moisture contents for typical construction soils. These results are in the form of the following information for each neutron emerging from the sample surface: distance from source to point of emergence, neutron energy at emergence, and three direction cosines characteristic of the emergent direction of motion. The counting yield of two BF_3-filled proportional counter detectors was predicted by the Monte Carlo simulation for 10 samples, and these predictions were compared to experimental results. The correspondence between the Monte Carlo simulation and the experimental results was found to be quite good. Results are given to indicate the effect of iron content and sample density on gage response. The uses of the Monte Carlo simulation program and results are discussed, including optimum gage design studies and calibrations of existing neutron gages. (auth)

9702 APPLICATION OF RI INSTRUMENTS IN CIVIL ENGINEERING WORKS. Takahata, Shiro (Ministry of Construction, Osaka). Kensetsu Kinki; 4: No. 3, 53-4(Mar 1969). (In Japanese).

The operation and performance of gamma-ray densimeters and neutron moisture gages were studied. It was found that the standard deviation is twice as large in the backscattering densimeter as in the penetration type. Density studies of soils and asphalt pavements are discussed. (TSS) (NSA of Japan)

Miscellaneous Instruments and Components

Refer also to abstracts 9578, 9984, 10155, 11117, and 11275.

9703 (ANL-7494) MEASUREMENT OF INHOMOGENEOUS MAGNETIC FIELDS USING A ROTATING DIPOLE SEARCH COIL. Hansen, Niels J. (Argonne National Lab., Ill.). Sep 1968. Contract W-31-109-eng-38. 47p. Dep. CFSTI.

The measurement of inhomogeneous magnetic fields using a rotating dipole search coil has been investigated for both two-dimensional fields and cylindrically symmetric three-dimensional fields. It is found that when the fields are expressed in terms of an appropriate series expansion, the coil shape may be determined such that the constant term of the expansion may be measured to any desired degree of accuracy. An optimum coil shape to minimize the contributions from terms of higher order is one with rectangular cross section and whose parameters satisfy the relation $(9/20)(r_2^5 - r_1^5/r_2^3 - r_1^3) - h^2 = 0$, where r_1 and r_2 are the outside and inside radii, and 2h is the full width. By use of such a coil with $x = r_1/r_2 = 0.3$, ignoring the fact that individual turns may not be flat and circular, but may actually be some sort of helical segment, and by ignoring possible deformations that may occur during the fabrication of the coil, except for a simple eccentricity of the rotation axis, the field of the Argonne double-focusing alpha-particle spectrometer may be measured with a theoretical precision of one part in 10^3. In actual practice, real imperfections in the coil plus other factors, such as the difficulty in measuring small voltages and the problems encountered when attempting to balance the phase of two similar signals, may limit the accuracy to about one part in 10^5. (auth)

9704 (CEA-BIB-158) PHOTOELECTRON SPECTROSCOPY. Lemarechal-Dupuis, Annick (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Oct 1969. 15p. (In French). Dep. CFSTI (U. S. Sales Only).

The spectroscopy of photoelectrons is a method of investigating atomic and molecular ionization potentials. The principle of the method, the various types of apparatus used and the most typical examples of known spectra are reviewed. (auth)

9705 (CEA-CONF-1364) APPLICATION OF ANALOG MATHEMATICS TO ATOMIC ENERGY. Caillet, C. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). June 1969. 22p. (In French). Dep. CFSTI (U. S. Sales Only).

A survey is given of the use of analog calculations by the C.E.A. The computers available are indicated. Three analog studies on reactors and nuclear power plants are described. These include the simulation of the behavior of fuel rods in boiling or pressurized reactors, calculation of the thermal stresses in the space between the principal vessel and the primary vessel of the Phenix Reactor, and the calculation of the mechanical and thermal stresses of a sodium-heated steam generator in the case of the rupture of a water pipe. The use of analog calculations in the study of accelerators and plasmas are discussed. Nuclear plants, such as installations separating chemical products, also have use of analog calculations. The type of calculations used are illustrated. Analog studies in chemistry, biology, medicine, and pharmacodynamics are often concerned in their nuclear application to the problems of compartments. (J.S.R.)

9706 (CEA-CONF-1366) DETECTION OF CLADDING RUPTURES. Roguin, Andre (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). June 1969. 21p. (In French). Dep. CFSTI (U. S. Sales Only).

The consequences of cladding ruptures, the causes of cladding ruptures, and the behavior of cladding ruptures are briefly described. The specifications of a good installation for the detection of cladding ruptures are summarized. The methods for the detection of cladding ruptures are based on the measurement of the concentration of fission products in the coolant. The characteristics of the detectors used in water-cooled reactors, liquid-metal cooled reactors, and gas-cooled reactors are indicated. Measurement of fission gases by the method of electric collection of their descendants is described. Some installations at graphite–gas reactors where the performances with respect to rapid detection, positive locating of the defective channel, and a continuous monitoring of the rupture were particularly impressive were briefly described. (J.S.R.)

9707 (CEA-R-3812) SAMPLING SYSTEM FOR FAST SINGLE PULSES. Zenatti, Daniel (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Sep 1969. 53p. (In French). Dep. CFSTI (U. S. Sales Only).

Thesis. Submitted to Univ. of Lyon, Faculte des Sciences, France.

The development of a device for the enlargement of the domain of application of classical oscilloscopes to the observation of fast single pulses by application of the sampling principle is described. Its principal characteristics are: bandwidth, 700 MHz; maximum sensibility, 50 mV; maximum amplitude of input signal, ±1 V; number of samples, 16; and samples separation, 0.2 ns. (auth)

9708 (EGG-1183-2216) HIGH-POWER LASER CARRIER INVESTIGATIONS. Technical Report Number S-461-R. Clark, J. C. (EG and G, Inc., Goleta, Calif.). Jun 1969. Contract AT-(29-1)-1183. 19p. Dep. CFSTI.

For California Univ. [Livermore]. Lawrence Radiation Lab.

Techniques for providing a smooth output pulse from a ruby laser by use of an intracavity nonlinear absorber as a control element were investigated. The nonlinear absorber consisted of a scattering cell filled with an anisotropic molecular liquid in which the onset of stimulated Rayleigh emission provided an abrupt nonlinearity. A pulse of several microseconds' duration and multikilowatt peak power output with minimum noise due to random fluctuations of intensity was desired. With only the scattering cell added to the ruby laser cavity the output pulses obtained were several hundred microseconds long with a peak amplitude of a few hundred watts. However, there was still residual spiking in the output to the extent of 20% of the peak amplitude. Use of the scattering cell in a Q-switched ruby laser provided 30-to-50 μsec pulses of 15 kilowatts peak power. These pulses were not reliably obtained, however, and their character was very sensitive to pump power and adjustment of cavity elements. Further experimental study is required to determine optimum parameters for obtaining the desired pulses. (auth)

9709 (INS-343) PROGRESS REPORT NO. 11, JANUARY–JUNE 1968. (Institute of Nuclear Sciences, Lower Hutt (New Zealand)). 45p. Dep. CFSTI (U. S. Sales Only).

Research and development projects are briefly outlined in instrumentation, nuclear physics, radiation research isotope geochemistry (stable isotopes), radioactive dating and radioactive fallout, and isotope applications. (W.H.K.)

9710 (KFK-951) HYDRAULIC OR PNEUMATIC DEVICE FOR READING THE POSITION OF A CONTROL ROD IN A NUCLEAR REACTOR. Muehlhaeuser, O. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Reaktorbauelemente). Apr. 1969 34p. (In German). (EUR-4170). Dep. CFSTI (U. S Sales Only).

The construction principles and test results of a hydraulic or pneumatic device for reading the position of a control rod in a reactor, which is completely separated from and independent of the positioning mechanism, are described. The device can be operated either hydraulically or pneumatically and can be used in water, steam, or gas and the temperature of the medium is of secondary concern. The reading device is based on the principle in a four-section hydraulic bridge circuit in which two sections are different so that the change of these two sections is a function of the positioning motion of the control rod. The necessary pressure drop for the operation of the bridge was provided by pressure decrease of the tapped reactor pressure and was maintained by a controller at constant height. (J.S.R.)

9711 (KFK-963) ON-LINE USE OF A CDC 1700 COMPUTER IN EXPERIMENT IN HIGH-ENERGY PHYSICS. Galster, S.; Hartwig, G.; Klein, H.; Moritz, J.; Schmidt, K. H.; Schmidt-Parzefall, W.; Wegener, D.; Bleckwenn, J. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Experimentelle Kernphysik). May 1969. 37p. (In German). Dep. CFSTI (U. S. Sales Only).

The construction and programming of a CDC 1700 computer, which is directly tied into a high energy physics experiment, are described. All data are first transferred to a plate storage and remain available for on-line evaluation. In the available computer time, a random number of freely chosen evaluation programs yields results. Independent and parallel to the on-line evaluation there is a selectable program for the optical representation of results. The data and partial results calculated are automatically transferred to storage on a magnetic tape. (tr-auth)

9712 (UCRL-50687) FALLOUT DISPLAY SYSTEM PROGRAM DESCRIPTION. Franklin, Paul (California Univ., Livermore. Lawrence Radiation Lab.). 17 Jun 1969. 340p. Dep. CFSTI.

The Fallout Display System (FODS) computer program which was originally developed by Systems Development Corporation and has been modified by the Lawrence Radiation Laboratory is described. The computer hardware, FODS program organization, data specifications, program details, procedures for changing the program, and complete listings of all software details are given. A Varian Data 620-I computer is used. (auth)

9713 AN EXPERIMENTAL TEST OF A PROPOSAL FOR DETERMINING THE ABSOLUTE EFFICIENCY OF A γ-RAY TRANSMISSION CIRCULAR POLARIMETER. Mackie, R. D. L. (Univ. of Edinburgh); Byrne, J. Nucl. Instrum. Methods; 76: 241-4(1969).

Results are reported of an experiment carried out to measure the analyzing efficiency of a γ-ray transmission circular polarimeter using the 344 keV γ-ray from ^{152}Gd. Although the results are of the order of magnitude expected it is concluded that the intervention of spurious effects makes this method inapplicable at low energies. An analysis of these effects indicates that the methods may be applied above 1 MeV to determine the efficiency at the highest γ-ray energy. (auth)

9714 THE EXACT OUTPUT VOLTAGE DISTRIBUTION OF A SATURATING DIODE-PUMP RATEMETER WITH RANDOMLY TIMED INPUT PULSES. Vincent, C. H.; Parker, J. B. (United Kingdom Atomic Energy Authority, Aldermaston, Eng.). Nucl. Instrum. Methods; 76: 253-7(1969).

An analysis is given to determine the output voltage distribution of a diode-pump ratemeter with randomly timed input pulses, when the mean input rate is high enough to make the output voltage comparable to the input pulse amplitude. An integral equation is found which exactly defines the distribution and which is suitable for numerical solution. Some typical distributions are given. Also, exact analytical formulae for the mean, standard deviation and skewness are derived from this equation. The results are summarized and compared with those of previously available theory. The case where a scale-of-two input circuit is used is covered in an appendix. (auth)

9715 ULTRA LINEAR RAMP GENERATOR FOR SLIDING PULSERS. Eichholz, J. J.; Strauss, M. G.; Bannon, R. W. (Argonne National Lab., Ill.). Nucl. Instrum. Methods; 76: 278-84(1969).

A ramp generator has been developed for use with voltage sampling pulse generators thereby providing pulses the amplitudes of which increase linearly with time (sliding pulser). The basic circuit of the ramp generator is an operational integrator which includes a high gain ($\sim 10^8$) chopper-stabilized amplifier and an integrating capacitor with polystyrene dielectric. The output voltage of the generator is a sawtooth with selectable ramp slopes of 0.01, 0.1 and 1.0 V/sec. Other features include (1) selectable ramp polarity, (2) adjustable ramp amplitude, (3) single or repetitive sweeps, and (4) an end-of-ramp pulse. The change in slope over 85% of the 10 V ramp is less than ±0.01% and over 55% of the range the incremental non-linearity is less than ±0.005%. The main contributors to the ramp non-linearity are dielectric absorption in the integrating capacitor, and change in capacitance as a function of the applied voltage. The incremental and differential linearity measurements and the design considerations are discussed. (auth)

9716 DATA PROCESSING SYSTEM BASED ON A SMALL COMPUTER FOR THE PLUTO RESEARCH REACTOR. Wright, S. B. (Atomic Energy Research Establishment, Harwell, Eng.). J. Brit. Nucl. Energy Soc.; 8: 303-8(Oct 1969).

A small computer was installed on the reactor PLUTO as an experiment in digital data logging and control for irradiation experiments. The system permitted the sampling of a few inputs every 20 ms, and other inputs at periods ranging from 1 s to 24 h at a maximum rate of 500 points/s. It was used for simple data logging of parameters such as the neutron flux and the reactor power, and also for closed loop control of irradiation rig furnaces. Experience with the system was good, and had some distinct advantages over conventional instrumentation. (UK)

9717 PRIMENENIE TSIFROVYKH I ANALOGOVYKH VYCHISLITEL'NYKH MASHIN V YADERNOI FIZIKE I TEKHNIKE. VYPUSK III. (Applications of Digital and Analog Computers in Nuclear Physics and Technology. Issue 3). Solov'ev, G. N. (ed.). Moscow; Atomizdat (1969). 140p.

Problems in computer control of cyclic and linear accelerators and in application of computer techniques for accelerator designs and computing experiments in physics are discussed in the nine articles included. The design of a memory device with an ultrasonic line and analyzer control of consequent operation, analog computer techniques for determining constants of wave propagation of space charge in charged particle beams, and determination of charged particle fields by analog computer techniques are also covered. (R.V.J.)

9718 FREQUENCY SWEPT NMR SPECTROMETER (Jan 16, 1969) (Engineering Materials). (California Univ., Livermore. Lawrence Radiation Lab.). (CAPE-1948).

40 drawings.

A high-resolution NMR spectrometer, which employs the Hewlett Packard 5100 A Frequency Synthesizer as the exciting source is capable of conventional high-resolution spectroscopy, as well as various double-resonance, spin decoupling, and NMR Fourier spectroscopy excitation experiments. This system is based on a 50 kHz time-sharing modulation method which reduces transmitter leakage into the receiver. A selectable internal- or external-proton NMR lock system operating at 60.025 MHz effects field-frequency stabilization. The probe, preamplifier, and internal-lock coil can be changed to investigate NMR nucleus of different gyromagnetic ratios. NMR spectra are stimulated by sweeping the frequency stabilizer through the appropriate range using a special solid-state digital programmer. In operation, the output of the programmed synthesizer f(t) is mixed with a 31 MHz signal from the synthesizer driver which extends the output range to 81 MHz. At the same time the NMR signal, stimulated by the swept-frequency source, is mixed with f(t) converting the NMR information to a 31 MHz intermediate frequency. Following amplification by a narrow-band 31 MHz receiver, the NMR signal is applied to a rf phase-sensitive detector whose phase-variable reference is derived from the same 31 MHz which is used for frequency conversion in the transmitter channel. All NMR signals are converted to 31 MHz where they are amplified and detected. A preamplifier and amplifier follow the probe and increase the NMR signal strength to levels where efficient conversion takes place in the receiver mixer. Time-share modulation is accomplished by control pulses from a timing programmer to the transmitter and receiver rf switches. (For details see TID-4100 Suppl. 56) (See also 23: 14086) (F.S.)

9719 SUPPRESSION OF AFTER-PULSING IN THE TYPE 58AVP PHOTOMULTIPLIER. Schrack, R. A.; Heaton II, H. T.; Schwartz, R. B. (National Bureau of Standards, Washington, D. C.). Nucl. Instrum. Methods; 77: 175-6(1970).

A technique for eliminating the after-pulse observed in photomultipliers after intense light pulses is described. (auth)

9720 A TIME-TO-AMPLITUDE CONVERTER CALIBRATION MODULE. Boulter, J. F.; Prestwich, W. V.; Kennett, T. J. (McMaster Univ., Hamilton, Ont.). Nucl. Instrum. Methods; 77: 163-6(1970).

A device to calibrate a range of time-to-amplitude converter timescales has been constructed in a single width NIM module using high speed integrated circuits and a 100 MHz crystal oscillator. (auth)

9721 THE HOLLOW-CATHODE GLOW-DISCHARGE AS A PULSED LIGHT SOURCE FOR STABILIZING SCINTILLATION DETECTORS. Hewitt, J. S.; Walker, J. (Univ. of Birmingham, Eng.). Nucl. Instrum. Methods; 77: 105-11(1970).

The application of the hollow-cathode glow-discharge as a stable pulsed light source has been investigated. A tube possessing nickel electrodes and argon filling was found to be capable of producing 40 ns pulses of violet light with a long-term amplitude stability of better than 0.1% when triggered by a thyratron. The repetition rate was 200 Hz and time jitter was approximately 5 ns with respect to the trigger pulse. The high amplitude stability was achieved after the tube had been aged for 4 months under pulsed operation and the gradual decrease in drift-rate observed during aging is believed to correspond to the approach to an equilibrium cathode geometry produced by sputtering. (auth)

9722 SEMIAUTOMATIC READOUT FOR STAGE COORDINATES FOR MULTIPLE MICROSCOPE SYSTEMS. Bashista, J.; Jensen, L.; O'Dell, F. W.; Stiller, B. (Naval Research Lab., Washington, D. C.). Nucl. Instrum. Methods; 77: 71-7(1970).

A system (HAREM) has been designed and constructed, with which one can semiautomatically record X, Y and Z coordinates from several microscopes on a single magnetic tape recorder, for subsequent computer processing. Coordinates are recorded with a precision of 2 μm and transcription errors have been eliminated. The coordinate position of the microscope stage is also visually displayed. The system has been installed on six Leitz Ortholux microscopes used for scanning nuclear research emulsions. (auth)

9723 SPINNING SINGLE CRYSTAL TOF METHOD FOR STRUCTURE ANALYSIS. Buras, B.; Giebultowicz, T.; Minor, W.; Rajca, A. (Univ. of Warsaw). Nucl. Instrum. Methods; 77: 13-20(1970).

A new time-of-flight method for single crystal structure studies is proposed and checked experimentally. In this method a polychromatic neutron beam of constant intensity is used and the single crystal sample spins (rotates) with a speed of the order 10^3 to 10^4 rpm. The intensities of neutrons scattered at a fixed angle by the spinning crystal are measured by means of a counter connected to a multichannel time analyzer. Examples of neutron patterns are given, the formula for the integrated intensity derived and the problem of extinction discussed in some detail. It is shown that using this method the extinction can be diminished or even excluded. (auth)

9724 A TRANSISTORIZED MULTICHANNEL ANALYSER SYSTEM FOR LOW LEVEL COUNTING WORK. Ragupathy, S. (Bhabha Atomic Research Centre, Trombay, India). Nucl. Instrum. Methods; 77: 61-70(1970).

A simple transistorized multichannel analyzer system adoptable for low level counting work is described. It consists of (1) an analog to digital converter, (2) a digital data processor, and (3) analog and digital readouts. Its performance and applications are also reported briefly. The circuits and system are simple and reliable with fastness adequate for most types of low level counting work. (auth)

9725 TOPICS IN ADVANCED MATHEMATICS FOR ELECTRONICS TECHNOLOGY. Paull, Stephen. Wiley Series in Electronic Engineering Technology. New York; John Wiley and Sons, Inc. (1966). 428p.

A wide-ranging introduction to a number of important topics in advanced mathematics selected for their applicability to problems in electronics is presented. The presentation is careful but nonrigorous, and is offered from the viewpoint of the electronics engineer and electronics technician rather than that of the mathematician. Among the topics covered are infinite series, Fourier series, Laplace transforms, vector analysis, and theory of determinants and matrix algebra. Problems and worked-out examples are included and special appendixes are included on Fourier coefficients, derivation of differential equations, and Laplace transform pairs. (auth)

9726 DIAPHRAGM FOR LIMITATION OF IONISING RADIATION BEAM. Atovmian, A. E.; Davydova, I. E.; Litvan, A. B.; Nesterenko, S. V.; Pukov, N. P.; Yagolkovskii, V. K. British Patent 1,175,216. 23 Dec 1969. Filed 22 Mar 1967.

The device described comprises wedge-like shielding elements accommodated in a housing and being slidably interconnected at their edges so as to be free to move in a plane perpendicular to the beam principal axis to form a polygonal aperture for emergence of a radiation beam. Ring gears are provided to move the shielding elements simultaneously or selectively through a common drive. Various alternative arrangements of diaphragms and drive are described. (UK)

9727 LIQUID METAL MONITOR. Roach, Peter Francis (to United Kingdom Atomic Energy Authority). British Patent 1,177,068. 7 Jan 1970. Filed 15 Jun 1966.

Reference is made to apparatus for monitoring flowing liquid metal for soluble impurities. The apparatus described comprises a duct for passage of the liquid metal, heat exchange means for cooling the liquid metal within the duct, electromagnetic means downstream of the heat exchange means for retarding the flow of liquid metal and arranged so that progressive precipitation of soluble impurities from the liquid metal reduces the retarding force of the electromagnetic means. Means are also provided for measuring the temperature of the liquid metal in the duct at the position of the electromagnetic means. The latter may comprise a pair of opposed magnetic poles, together with a pair of terminals for the passage of electricity through the liquid metal in the duct, the poles and terminals being disposed on mutually perpendicular axes which are perpendicular to the axis of the duct. The heat exchange may comprise an air cooler, and a secondary heat exchange means may be provided in the region of the electromagnetic means. The latter may also comprise an eddy current brake. (UK)

9728 ELECTRICAL CONNECTOR AND THE COMPONENT PLUG AND SOCKET. Foster, Kenneth; Price, Michael (to United Kingdom Atomic Energy Authority). British Patent 1,175,971. 1 Jan 1970. Filed 9 Jun 1966.

The electrical fittings described are intended for use in nuclear reactor core environments. The plug has a number of conductive contacts, and the socket has a similar number of such contacts. Means are provided to hold the plug contacts away from the socket contacts during insertion of the plug and to urge the plug contacts against the socket contacts on completion of insertion of the plug. The plug may have a flat key-like portion with resilient contacts in a line along one of its longitudinal faces, and the socket a cavity which is complementary to this key-like portion and fitted with fixed contacts. A spacing projection is provided on the key-like portion of the plug, this projection slides on a rib member in the socket to hold the plug contacts away from the socket contacts during insertion of the key-like portion into the socket cavity. The rib member has a recess to accommodate the spacing projection when the plug is fully inserted, together with means for urging the plug contacts against the socket contacts. (UK)

9729 PULSE HEIGHT COMPENSATION IN TIME TO AMPLITUDE CONVERSION. Thieberger, P. A. (to United States Atomic Energy Commission). U. S. Patent 3,484,703. 16 Dec 1969.

The apparatus and method for compensating for the pulse height dependence of the time measurement performed by time-to-amplitude converter means for pulse-producing nuclear particle detectors are described. Correcting signals are provided for the time-to-amplitude conversion during coincidence between pulses from the detectors only when said coincidence is capable of accurate compensation over a wide range of pulse heights. (AEC)

9730 MAIN TRENDS IN THE USE OF STANDARD ACTIVATION ANALYSIS APPARATUS IN INVESTIGATING ROCKS AND ORES. Savosin, S. I.; Berzin, A. K.; Leipunskaya, D. I.; Sulin, V. V.; Shimelevich, Yu. S. Tr., Vses. Nauch.-Issled. Inst. Yadern. Geofiz. Geokhim.; No. 1, 20-41(1968). (In Russian).

A number of new complexes of apparatus and other technical means of activation analysis, developed by the State Committee on the Use of Atomic Energy and the All-Union Scientific Research Institute of Nuclear Geophysics and Geochemistry, are described. One neutron activation analysis laboratory uses an RG 1 type of nuclear reactor, another an NG 160 type neutron generator; another uses a miniaturized subcritical uranium assemblage of SO 1 type; also described is a gamma activation analytical complex with laboratory betatrons. Some results obtained with the apparatus described are presented. (Geophys. Abstr.)

Radiation Effects on Instruments and Instrument Components

9731 (COO-1105-102) TL VS R IN LiF: A PROPOSED MATHEMATICAL MODEL. Cameron, J. R.; Zimmerman, D. W. (Wisconsin Univ., Madison. Dept. of Physics). [nd]. 12p. Dep. CFSTI.

Correlations are presented between a model assuming the creation of traps by irradiation, and thermoluminescence measurements on TLD-100 and H63A LiF powders. Excellent agreement was found between the model and the data over the range 1 to 500,000 R. (D.L.C.)

LIFE SCIENCES

Biochemistry, Physiology, and Molecular Biology

Refer also to abstract 9796.

Basic Processes

Refer also to abstracts 9639, 9665, 9873, and 9925.

9732 SUPPRESSION OF THE TENDENCY OF γ-IRRADIATED LYSOZYME FOR AGGREGATION AFTER TREATMENT WITH MERCAPTOETHYLAMINE. Maksimov, V. I.; Osipov, V. I.; Kavergneva, E. D. (Inst. of Organic Chemistry, Moscow). Radiobiologiya; 9: 355-8(1969). (In Russian).

Some properties of irradiated lysozyme (dose 30 Mrad, in nitrogen, in the dry state, room temperature) were investigated after treatment with mercaptoethylamine (after the reaction of disulfide exchange). It was shown that despite the slight increase in enzymatic activity, the tendency of the irradiated protein for aggregation is sharply reduced. The data on the uv absorption spectra and fluorescence spectra of the irradiated protein permit us to speak of damage to tryptophan and tyrosine after the irradiation of protein with a high degree of probability. This may lead to the impossibility of complete repair both of structure and of activity. It is suggested that the observed conformational changes in the irradiation of proteins, associated with disruptions of the ability to form quaternary structures, are directly related to the phenomena of damage at the organismic level. New hypotheses are advanced on the possible mechanism of the radioprotective action of mercaptoethylamine. (tr-auth)

9733 ELECTRON PARAMAGNETIC RESONANCE STUDY OF X-RAY AND γ-RAY IRRADIATED PEPTIDES IN THE SOLID STATE. Meybeck, Alain; Windle, John J. (Dept. of Agriculture, Albany, Calif.). Radiat. Res.; 40: 263-75(Nov 1969).

The following dipeptides have been irradiated with ^{60}Co γ-rays in liquid nitrogen: glycyl-L-phenylalanine, glycyl-L-tyrosine, glycyl-L-tryptophane, L-phenylalanyl-glycine, L-tyrosyl-glycine, L-tryptophyl-glycine, L-alanyl-L-phenylalanine, L-alanyl-L-tyrosine, L-analyl-L-tryptophane, L-phenylalanyl-L-alanine, L-tyrosyl-L-alanine, and L-tryptophyl L-alanine. Their EPR spectra have been recorded at −180 or −160°C and at room temperature. Detectable free radicals are formed at low temperature only on glycine and alanine and are of the types $-\dot{C}H_2$ and $-\dot{C}H(CH_3)$ respectively. Upon warming to room temperature the EPR signals of peptides containing glycine or alanine in the N-terminal position change to mostly unresolved spectra. For the C-terminal peptides, L-Phe-Gly and L-Tyr-Gly, warming results in a spectrum attributed to a $-NH-\dot{C}H-COO^-$ radical appear, while for L-Phe-L-Ala, L-Tyr-L-Ala and L-Trp-L-Ala a spectrum believed to result from a $-NH-\dot{C}(CH_3)-COO^-$ radical appears after standing at room temperature. The radicals observed in peptides at room temperature after γ-irradiation at low temperature are the same as after x- or γ-irradiation at room temperature. (auth)

9734 CYTOLOGICAL AND AUTORADIOGRAPHIC STUDY ON RIBONUCLEIC ACID SYNTHESIS IN PREIMPLANTATION EGGS OF THE SYRIAN HAMSTER. Utakoji, Tadashi (Univ. of Texas, Houston). Cytologia (Tokyo); 34: No. 1, 93-102 (Mar 1969).

Ribonucleic acid (RNA) synthesis in preimplantation stage embryos of the Syrian hamster was studied cytologically and autoradiographically using whole-mount squash preparations. Cytologically, the first cleavage chromosomes were large and extended, and the relational coiling was detected. Pronucleus and the early 2-cell stage nucleus were morphologically similar and contained a large amount of heteropycnotic blocks, but no ribonucleoprotein was demonstrated either with May-Grünwald-Giemsa staining or with acridine orange. In the late 2-cell stage, however, the morphology of the nucleus differed considerably from that of the pronucleus and of the early 2-cell stage. Several ribonucleoprotein-containing nucleoli appeared in each nucleus, and the rest of the nuclear area showed coarse chromatin network with scattered heteropycnotic blocks. Chromosomes, that were extended in the first cleavage, became gradually shorter in the course of preimplantation development. In some metaphases in the blastocyst, chromosomes were approximately as compact as those of adult tissues. Nucleolar RNA synthesis was demonstrated in the late 2-cell stage. Heavy ^{3}H-uridine incorporation appeared in the nucleoli of blastomeres from the late 2-cell stage to the blastocyst. Chromatin was also active in RNA synthesis. No grains above the background level were observed in the cytoplasm of metaphase and anaphase cells of these embryos. (auth) (NSA of Japan)

9735 INCORPORATION OF ^{75}Se-SELENOMETHIONINE IN HUMAN PERIPHERAL LYMPHOCYTES AS AN IN VITRO TEST OF GLOBULIN-SYNTHESIZING CAPACITY. Cheng, Frank H. F.; Peterson, Richard E.; Evans, Titus C. (Univ. of Iowa, Iowa City). J. Nucl. Med.; 10: 63-7(Feb 1969).

An in vitro assay procedure is described for measuring the globulin-synthesizing capacity of human peripheral lymphocytes in the presence of ^{75}Se-selenomethionine and phytohemagglutinin (PHA). Lymphocytes cultured at 37°C for 24 hr incorporated small amounts of ^{75}Se-selenomethionine into globulin protein in unstimulated cultures, while lymphocytes in the presence of PHA incorporated a much greater amount of this amino acid analog in stimulated cultures. The ratio between radioactivities of stimulated cultures and unstimulated cultures gave an index of stimulation by PHA on the globulin-synthesizing capacity of lymphocytes. Values of such an index of stimulation by PHA for lymphocyte cultures obtained from twenty clinically normal individuals were 2.75 ± 0.63. Several parameters and reproducibility of the assay were also tested. (auth)

9736 TOTAL-BODY NITROGEN AND PROTEIN DETERMINED BY IN VIVO FAST-NEUTRON ACTIVATION ANALYSIS. Nagai, Teruo (National Inst. of Radiological Sciences, Chiba, Japan); Fujii, Isao; Muto, Haruo; Inouye, Tamon. J. Nucl. Med.; 10: 192-6(Apr 1969).

In vivo 14 MeV fast neutron activation analysis for total-body nitrogen and protein in mice was successfully performed with a high degree of accuracy. The results obtained with this technique agree to a high confidence level with the analyses performed by standard chemical methods. An appraisal of the study indicated that in vivo 14 MeV fast neutron activation analysis was a simple, useful, and nondestructive technique for measuring nitrogen and protein in the living body without serious radiation effects. Automated data processing with a digital computer gave highly accurate results. (auth)

9737 APPLICATION TO RESEARCH AND ITS PROBLEMS: AGRICULTURE. Shibuya, Masao (National Inst. of Agricultural Sciences, Tokyo). Genshiryoku Kogyo, 15: No. 5, 25-30 (May 1969). (In Japanese).

Isotope applications to research are divided broadly into three works, i.e., tracer study, irradiation study and radioactivation analysis. Concerning the studies on agriculture, isotope tracer method is of very wide application, and this method accounts for almost all of the isotope application. In many cases of cultivating plants, the isotopes must be pursued for a long time after the administration. In case of the isotope ^{32}P, very weak radioactivity must be determined. When ^{32}P-labeled phosphatic manure is applied, the amount of administration must be decided by considering least traceable amount and exposure to radioactivity. Safety is very important, especially in the beginning of the experiment and for the operation, it is necessary to wear a β-ray cap and gown. Further tracer studies have been made by using ^{15}N, ^{45}Ca, ^{203}Hg, and ^{35}S for labeled manures and agricultural chemicals. Most irradiation study concerns improvement of breed caused by irradiation and induced mutation. This had been done on seeds, but irradiation on growing plants can be done easily by irradiating with γ rays. In addition to the above, the systematic successive non-destructive method, the non-destructive radioactivation analysis with Ge(Li) detector and active tracer have been studied, and these will be developed further. (NSA of Japan)

Metabolism, Physiology, and Toxicology

Refer also to abstracts 9265, 9795, 9799–9802, 9886, 9894, 9902, 9903, 9922, 9968, and 9977.

9738 (LF-tr-1) THE INHALATION OF RADIOACTIVE SUBSTANCES. PART III. URANIUM AND THORIUM (A LITERARY REVIEW). Gensicke, F.; Nitschke, H. W. Translated by A. A. Horvath (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.), from report SZS-3/69. 21p. Dep. CFSTI.

An abstract of this report was prepared from the original language and appeared in NSA as 23: 31612. (C.H.)

9739 THE STUDY OF THE PENETRATION OF ^{89}Sr IN THE INTACT SKIN OF RATS. Zaichik, V. E.; Khodyreva, M. A. Gig. Sanit.; No. 11, 38-41(Nov 1968). (In Russian).

A study of the distribution of absorbed ^{85}Sr according to depth as a function of the time from the moment of application of the isotope on skin revealed a quantitative absorption of the isotope in different layers of the skin. It was established, for example, that upon application of a 1N solution of ^{85}Sr-hydrochloride to the skin, in the course of the first minutes after application an intense infiltration into the dermis of the organism is noted. After a 15-minute exposure the substance penetrates the dermis to the extent of about 12% and after 6 hr up to 40%. (tr-auth)

9740 EFFECT OF ALUMINUM PHOSPHATE GEL ON RADIOSTRONTIUM ABSORPTION IN MAN. Spencer, Herta; Lewin, Isaac; Samachson, Joseph; Belcher, Mary J. (Veterans Administration Hospital, Hines, Ill.). Contract AT(11-1)-1231-37. Radiat. Res.; 38: 307-20(May 1969).

The effect of aluminum phosphate gel on the absorption of radioactive strontium was studied in man under constant and controlled dietary conditions, with a low calcium intake in 11 of the 13 cases. Studies previously performed in this laboratory have shown that 100 ml of this compound given immediately prior to the oral administration of ^{85}Sr decreased the absorption of radiostrontium by an average of 87%. In the present investigation, the effectiveness of aluminum phosphate gel, given one-half hour and one hour after the ingestion of radiostrontium, was studied on the absorption of this radioisotope in man. The absorption of ^{85}Sr was decreased by an average of 57% when aluminum phosphate gel was given at one-half hour, and by an average of 43% when this compound was given at one hour. Amounts of 100 ml of aluminum phosphate gel were as effective as 200 ml or 300 ml. The absorption of ^{85}Sr was decreased in all patients receiving a low calcium intake and in one patient receiving a high calcium intake. There was no decrease in ^{85}Sr absorption in a second patient maintained on a high calcium intake. The suitability of this nontoxic, well-tolerated antacid for the prevention of absorption of radioactive strontium in case of acute exposure to this radioisotope in man is discussed. (auth)

9741 REDUCTION OF RADIOSTRONTIUM UPTAKE IN THE RAT. Friedland, Joan A.; Brdlik, Otto B.; Methfessel, Alfred H.; Spencer, Herta (Veterans Administration Hospital, Hines, Ill.). Contract AT(11-1)-1231-36. Radiat. Res.; 38: 340-8(May 1969).

Ten experiments were performed in rats to study the effect of aluminum phosphate gel on the uptake of radiostrontium in bone. Aluminum phosphate gel was given by gastric intubation, immediately prior to, immediately after, and at 10 minutes, 30 minutes, and one hour after the oral administration of $^{85}SrCl_2$. The uptake of ^{85}Sr in bone was determined in groups of rats sacrificed at one hour and at 24 hours following the oral ^{85}Sr administration. The ^{85}Sr blood levels and the ^{85}Sr content in the gastrointestinal tract were determined in addition to the ^{85}Sr bone uptake in groups of rats sacrificed at one hour following the administration of the radioisotope. In the rats sacrificed at one hour, aluminum phosphate gel, given either immediately prior to or immediately after the oral dose of ^{85}Sr, decreased the ^{85}Sr blood level by an average of 85% and the bone uptake by an average of 88%. At 10 minutes, ^{85}Sr uptake in bone was decreased by an average of 62%, while at one-half hour the decrease averaged only 35%. When aluminum phosphate gel was given at the same time intervals to rats sacrificed at 24 hours, the results were similar. However, when aluminum phosphate gel was given at one hour after the oral dose of ^{85}Sr, to rats sacrificed at 24 hours, the uptake of the radioisotope in bone was unchanged. The decrease in ^{85}Sr concentration in blood and bone was associated with a corresponding increase of the ^{85}Sr content in the gastrointestinal tract. These studies show that aluminum phosphate gel is effective in decreasing the uptake of ^{85}Sr in bone as a result of decreased absorption of radiostrontium. (auth)

9742 EFFECT OF AGE ON THE ^{131}I METABOLISM AND THE RADIATION SENSITIVITY OF THE RAT THYROID. Sikov, Melvin R. (Battelle-Northwest, Richland, Wash.). Contract AT(45-1)-1830. Radiat. Res.; 38: 449-59(May 1969).

Rats of various ages were exposed to graded levels of ^{131}I, and randomly selected animals were sacrificed after 1, 3, or 7 days to determine radiation doses to the thyroid glands. The doses were found to vary with age and were not a linear function of administered dose. After four additional months, the remaining rats were injected with a tracer dose of ^{131}I and sacrificed 24 hours later. Radiosensitivity was expressed as the initial radiation dose, in rads, required to reduce incorporation of the tracer to 50% of control levels. On this basis, values of 18,000, 12,000, 5300, and 970 rads were obtained for the initial exposure of adult, weanling, newborn, and prenatal rats, respectively. Alterations in growth and in extrathyroidal iodine metabolism were also noted in these animals. These effects varied with age and dose, but it was not established whether they were direct radiation effects or secondary to the induced hypothyroidism. (auth)

9743 ADAPTATION TO EQUIVALENT VISIBLE AND HIGH-ENERGY QUANTA. Dawson, William W. (Univ. of Florida, Gainesville). Contract AT(40-1)-3599. Radiat. Res.; 38: 425-36(May 1969).

By adjusting to equivalence the stimulating effectiveness of light and x rays, the processes of adaptation were measured by rate of optic nerve unit discharge. Light adaptation is a simple exponential function. Adaptation to x irradiation is a complex function composed of an early exponential decay in response rate and a late exponential rise in response rate. The response to light returned to normal three minutes after x-ray adaptation was terminated. The hypothesis that light and x-rays have identical effects on rhodopsin-bearing visual systems was not supported. (auth)

9744 THE DISTRIBUTION AND CONCENTRATION OF ^{75}Se-SELENOMETHIONINE IN MAN. Ben-Porath, Moshe (Elscint, Ltd., Haifa, Israel); Kaplan, Ervin. J. Nucl. Med.; 10: 709-10(Nov 1969).

Data are presented on the tissue distribution of ^{75}Se-selenomethionine in man at various times following intravenous injection. (C.H.)

9745 THE INFLUENCE OF ZINC GLUCONATE AND CASEIN HYDROLYSATE ON THE FLUID AND TISSUE KINETICS OF ^{65}Zn IN THE BABOON PROSTATE. Schoonees, R. (Univ. of Stellenbosch, Bellville, S. Afr. Karl Bremer Hospital, Bellville, S. Afr.); de Klerk, J. N.; Johnston, G. S.; Murphy, G. P. J. Surg. Oncol.; 1: 123-30(1969).

The clearance of ^{65}Zn from the bloodstream following an intravenous injection of $^{65}ZnCl_2$ was significantly delayed by the intravenous administration of stable zinc gluconate 15 min before and the addition of 5% casein hydrolysate to the $^{65}ZnCl_2$. This resulted in a higher blood ^{65}Zn concentration maintained for a longer period than was the case when only the $^{65}ZnCl_2$ was injected. The uptake of ^{65}Zn by a number of organs, especially the liver, pancreas, spleen, adrenal, kidney, and caudal prostate, was suppressed by the addition of zinc gluconate and Amigen (5% casein hydrolysate) to the $^{65}ZnCl_2$. The ^{65}Zn uptake by the skin, testis, epididymis, bladder, and aorta was enhanced by adding zinc gluconate and Amigen to the $^{65}ZnCl_2$. This also resulted in a raised pancreas/liver ratio. The caudal prostatic ^{65}Zn uptake was significantly suppressed by the use of stable zinc gluconate prior to injection of $^{65}ZnCl_2$. In both groups the caudal portion of the prostate responded much better to exogenous testosterone than the cranial portion. Zinc gluconate treatment, in general, prevented the rise in prostatic ^{65}Zn uptake observed between the fourth hour and sixth day following the injection of $^{65}ZnCl_2$. The higher blood ^{65}Zn radioactivity and perhaps the blocking of ^{65}Zn uptake sites in the kidney by stable zinc gluconate resulted in a much higher output of ^{65}Zn in the urine than was the case when only $^{65}ZnCl_2$ was used. By the second day, however, the blood and urine concentration of ^{65}Zn had returned to almost normal values. The results obtained in this study, using baboons, assume great significance by virtue of their easier application to man than is the case in studies involving rats and dogs. The use of stable zinc gluconate in addition to $^{65}ZnCl_2$ partially blocked the liver uptake of ^{65}Zn. This may assist in successful pancreatic scanning. The stable zinc gluconate partially blocked the uptake by the prostate of subsequently injected ^{65}Zn. (auth)

9746 COEFFICIENTS OF ACCUMULATION OF ^{90}Sr BY LIVE AND DEAD MARINE PLANTS. Baranova-Ryndina, D. D.; Polikarpov, G. G. (Inst. of the Biology of the Southern Seas, Sevastopol). Radiobiologiya; 9: 468-72(1969). (In Russian).

High coefficients of accumulation of strontium-90 are characteristic both of live and of killed brown algae. During decomposition and detritus formation, there is a liberation of radiostrontium into the surrounding medium. Low coefficients of accumulation of strontium-90 are characteristic of live and killed green and red algae and flowering plants, as well as their detritus. The nature of the accumulation of strontium-90 by live and killed marine plants described may be directly related not with processes of vital activity itself, but with rather stable structures, which are preserved for some time in the killed organisms. (tr-auth)

9747 RADIOACTIVE IODINE UPTAKE BY THYROID OF BREAST-FED INFANTS AFTER MATERIAL BLOOD-VOLUME MEASUREMENTS. Bland, E. P.; SelwynCrawford, J.; Docker, M. F.; Farr, R. F. (Birmingham Maternity Hospital, Eng.). Lancet; 11: 1039-40(15 Nov 1969).

Investigations of two patients showed that when routine blood-volume studies, using serum-albumin labelled with ^{125}I, were made on a mother at the time of delivery, a considerable amount

of radioactive iodine was subsequently transmitted to the infant in breast milk. This might increase by a factor of 10 the risk that the child would later develop thyroid cancer. Measurements taken over 8 days showed by extrapolation that the total infant intake was 0.5 μCi and 0.6 μCi in the two cases. The thyroid doses were calculated to be 2.0 and 2.5 rad, assuming effective half-lives of 9 days in the infant thyroids. This took account of inorganic iodine alone and the dose may have been up to 30% higher if the protein-bound portion had been liberated. (UK)

9748 DISTRIBUTION OF PARENTERALLY ADMINISTERED ^{45}Ca IN BONES OF GROWING PIGS. Pond, W. G.; Lovelace, F. E.; Walker, E. F. Jr.; Krook, L. (Cornell Univ., Ithaca, N. Y.). J. Anim. Sci.; 29: 298-302(Aug 1969).

A comparison was made of the uptake of injected ^{45}Ca by the nasal turbinate, humerus, femur, vertebra, mandible, and teeth of young pigs fed an adequate diet. Five Hampshire littermate and five Yorkshire littermate 4-week-old pigs averaging ~8 Kg body weight were injected with an isotonic solution of $^{45}CaCl_2$ intraperitoneally or intravenously (100 μCi of ^{45}Ca/Kg of body weight). The ^{45}Ca concentration (μCi ^{45}Ca/mg total Ca) of the nasal turbinate paralleled that of the proximal and distal ends of the humerus, reaching a peak after 6 hr and remaining through day 4 followed by a decline from day 4 to 8 and a further decline from day 8 to 16. The shaft of the humerus retained a constant ^{45}Ca concentration throughout the 16-day period, probably reflecting early uptake by the subperiostium and subsequent trapping of the isotope in deep layers of bone as accretion continued. The femur showed the same trend. The first lumbar vertebra and mandible were similar in activity to the ends of the femur and humerus and to the nasal turbinates at each time interval. The teeth showed the lowest activity and the frontal bone was intermediate. There was a rapid disappearance of ^{45}Ca from the blood following intraperitoneal injection, but a small amount persisted even 16 days after injection, probably reflecting re-entry into the circulation after removal from bone during remodeling. Fecal and urinary losses of ^{45}Ca were continuous over a 16-day period and represented 10% (5% in feces, 5% in urine) of the amount injected. The similarity of ^{45}Ca uptake by the nasal turbinate and by the growth plates of long bones suggests that areas of active bone growth in different parts of the skeleton of the pig have similar turnover rates. The nasal turbinate, a tubular cancellous bone, may, therefore, be more susceptible to excessive resorption than the long bone as an organ even though no more susceptible than the growth plate of long bones as a tissue. (BBB)

9749 RADIOACTIVE ^{18}F IN SOIL AND PLANTS. Romney, E. M.; Wood, R. A.; Wieland, P. A. T. (Univ. of California, Los Angeles). Soil Sci.; 108: 419-23(Dec 1969).

Radioactive ^{18}F (112 min half-life) was useful for soil and plant experiments that could be completed within ten half-lives from its production. It was unsuitable for studying fluoride uptake by plants from soil because of its short half-life. Soils and minerals had different ^{18}F sorption capacities. The sorption of ^{18}F conformed to known reactions which were rapid in minerals having a small proportion of internal surface, such as kaolinite, and slow in minerals having a high proportion of internal surface, such as montmorillonite. Fluorine 18 was readily taken up by roots from nutrient media and translocated throughout alfalfa, bean and tomato plants where it concentrated more in leaf than in stem tissues. Stable fluoride and other non-isotope carriers inhibited root uptake of ^{18}F. Foliar-absorbed ^{18}F was distributed in a pattern similar to that from root uptake, except that it concentrated highest in young leaves and in young buds at the growing tips and leaf axils. The ^{18}F absorbed by foliage was translocated to roots and released into nutrient media. Leaf tissue that had been damaged by ozone-oxidized unsaturated hydrocarbons (smog) did not accumulate ^{18}F. (auth)

9750 RETENTION OF RADIOCESIUM BY RATS BEFORE AND AFTER WEANING. Lengemann, F. W. (New York State Veterinary Coll., Ithaca, N. Y. Cornell Univ., Ithaca, N. Y.). J. Nutr.; 99: 419-24(Dec 1969).

Rat pups were given intraperitoneal injections of ^{134}Cs at 4 days of age, and the retention of the radiocesium was followed by whole-body counting. Up to the time of weaning, the pups lost half of the radiocesium every 10.9 days. After weaning, the rate of loss increased markedly and the body retention function became multiexponential rather than the single exponential observed during nursing. Experimental procedures ruled out recycling of radiocesium through the dams and the physical nature of the diet after weaning as being contributory factors to the changes observed in cesium retention. The experiments suggest that the higher potassium intake after weaning may be responsible for the sharp change in retention. (auth)

Radiation Effects

Refer also to abstracts 9910, 9921, 9940, 9944, 9947, and 9980.

9751 (CONF-690303-, pp 23-9) OBJECTIVES OF BIOMEDICAL RESEARCH IN RELATION TO ATOMIC ENERGY. Totter, John R. (Division of Biology and Mecicine (AEC), Washington, D. C.).

The objectives of biomedical research in relation to atomic energy can be stated as follows: to learn to live with radiation and radioactivity inexpensively and surely; and with a minimum of hazard or disturbance to people anywhere, and, through applications of atomic energy to biology and medicine, to bring additional benefits to the public. The accomplishments to date with respect to these objectives are discussed in terms of the participation of the AEC in the progress achieved in the field of biomedical research including; molecular genetics and immunogenetics, radiobiology, radionuclide transport, terrestrial ecology, biochemistry and molecular biology, and basic chemical research. The participation of the AEC in inter-agency projects on a national scale is also discussed, including research in the areas of; national defense, cancer, genetic mutations, aging, and environmental research. The role of the National Laboratories in these programs is mentioned. (E.R.B.)

9752 (COO-1754-2) EFFECT OF WHOLE BODY X AND γ-IRRADIATION ON THE BIOSYNTHESIS OF CERTAIN SERUM PROTEINS. Annual Progress Report, December 1, 1968-November 31, 1969. Neuhaus, Otto W. (South Dakota Univ., Vermillion. School of Medicine). Contract AT(11-1)-1754. 7p. Dep. CFSTI.

X irradiation suppressed the amino acid incorporating capacity of microsomal subcellular systems. This effect was also observed in pair-fed rats. Suppression of albumin synthesis was observed primarily in the microsomes and to a lesser degree in the cell sap. The effect is not to restrict the functioning of the microsomes since they act normally with added poly U. Irradiation did inhibit the biosynthesis of liver polysomal and nuclear RNA. This effect is not reproducible with inanition alone. Preliminary results showed that irradiation led to an increase in polysomal aggregation while inanition results in depolymerization. X and γ irradiation resulted in a marked increase in the uptake by the liver of α-aminoisobutyric acid, thus showing a marked change in cellular permeability. (auth)

9753 ULTRASTRUCTURAL PECULIARITIES OF THE NUCLEAR MEMBRANE AND RELATIONS BETWEEN THE NUCLEUS AND CYTOPLASM FOLLOWING THE ACTION OF PENETRATING RADIATION. Abramyan, K. S. (Inst. of Experimental Biology, Erevan). Biol. Zh. Arm.; 21: No. 11, 86-91(Nov. 1968). (In Russian).

An electron microscopic investigation of the salivary gland cells of butterfly larvae was conducted after their total irradiation to a dose of 20 kR at a dose rate of 700 R/min. Fixing was conducted through 1.6 hr and 1 and 2 days. The formation through excavation and the layers of the nuclear membrane are considered, and its structural components are described in detail. It was found that the migration of substances from the nucleus to the cytoplasm after irradiation was noticeably strengthened in comparison with controls. This is reflected in the intensified development of the apparatus for protein synthesis in the cytoplasm. (tr-auth)

9754 THE STATE OF THE ENDOCRINE SYSTEM DURING ACUTE RADIATION SICKNESS IN DOGS. Bril, E. E.; Livshits, I. B.; Martyanova, L. Ya.; Radyuk, K. A.; Chevlytko, A. A. Vestsi Akad. Navuk BSSR, Ser. Biyal. Navuk; No. 4, 64-8(1968). (In Belorussian).

The results of the detailed investigation of the concentration of different hormones in the blood of dogs that had obtained a lethal dose of x irradiation are presented. The following activities were studied; the activity of adrenocorticotropin in plasma, the content of 17-oxycorticosteroids, hormonal activity in the thyroid gland using ^{131}I-labeled thyroxine, and the free and bound insulin content of blood serum. The general clinical, hematological, and biochemical indexes of the blood of dogs were studied simultaneously. The investigation was conducted up to the time of irradiation and following each of three or four single whole-body x irradiations at a dose of 600R. The order of significant shifts in the hormonal balance in the bodies of the irradiated dogs was determined. The results showed that ionizing radiation, in the early periods after irradiation, has a mobilizing influence on certain endocrine functions. Subsequently, inhibition of endocrine function develops leading to a reduction in certain hormonal indexes in the blood. (tr-auth)

9755 THE MODIFICATION OF RADIOINDUCED BIOCHEMICAL CHANGES BY THE INTRODUCTION OF STEROID HOR-

MONES. Fomichenko, K. V. Vestsi Akad. Navuk BSSR, Ser. Biyal. Navuk; No. 4, 80-6(1968). (In Belorussian).

Alterations in protein exchange processes under the influence of x rays and intermediate neutrons were studied in animals that were given massive doses of hydrocortisone. The results showed that under these conditions a slight deficit of nucleoproteins develops in brain tissue and more significantly in liver tissue. Also, a reduction of the histone fractions of proteins occurs in the liver 1 day after the combined action. The other proteins in these tissues remain unchanged. The nature of the radioinduced biochemical changes in the tissues of the animals that received hydrocortisone, in contrast to the changes characteristic for those animals that received irradiation only, indicate that in the former, the endocrine factor plays a role. (tr-auth)

9756 CHANGES IN THE METABOLISM OF NAD AND $NADH_2$ IN THE CEREBRAL HEMISPHERE OF THE BRAIN IN RATS THAT WERE X-IRRADIATED IN SMALL DOSES (40R). Shalushkova, L. P. Vestsi Akad. Navuk BSSR, Ser. Biyal. Navuk; No. 4, 87-90(1968). (In Belorussian).

In the cerebral hemispheres of the brain of rats there are 202 mkg/g of NAD and 254 mkg/g of $NADH_2$. Following a single x irradiation of the animals in a dose of 40R, significant disturbances in the metabolism of the nicotinamide coenzymes were established. These were expressed as a reduction in the content of NAD + $NADH_2$ and an increase in the ratio of NAD/$NADH_2$ during the time of the experiment. This was distinguished mainly by the loss of the level of restored coenzyme. In order to clarify the causes of the disturbances in the state of NAD and $NADH_2$, experiments were conducted on the enzymatic decomposition of NAD and the activity of $NADH_2$–oxidase in the brain of irradiated rats. The results indicated that x irradiation caused a widespread statistical increase in the overall activity of the enzymes that cleave NAD and activate $NADH_2$–oxidase, which in turn probably causes a decrease in the content of coenzymes in the brain of intact irradiated rats. (tr-auth)

9757 INFLUENCE OF IONIZING RADIATION ON THE ADAPTIVE SYNTEHSIS OF TRYPTOPHAN PYRROLASE IN THE PROCESS OF POSTNATAL DEVELOPMENT OF RATS. Mel'nikova, S. K.; Kuzin, A. M. (Inst. of Biological Physics, Pushchino-on-Oka, USSR). Radiobiologiya; 9: 436-9(1969). (In Russian).

The influence of whole-body x-irradiation on the development and adaptive intensification of the activity of tryptophan pyrrolase in the rat liver at various periods after birth was investigated. The irradiation of one day old rats at a dose of 300 R entirely blocks the ability for adaptive increase in enzyme synthesis up to the 20th day of development, which is observed among the control animals during this period. Irradiation 24 hrs after birth also inhibits the process of appearance of the enzyme by 40 to 50%. In the case of irradiation of two week old animals, when the controls already manifest a distinct ability for adaptive synthesis, irradiation does not induce any inhibition of development all the way up to the 20th day. Possible mechanisms of the data obtained are discussed. (tr-auth)

9758 CHANGE IN THE ACTIVITY OF THE RESPIRATORY ENZYMES IN ANIMALS WITH DIFFERENT RADIOSENSITIVITIES. Balmukhanov, S. B.; Chteshev, A. B.; Abdrakov, B. K.; Satkhozhina, E. A. (Inst. of Biophysics, Moscow. Inst. of Experimental Biology, Alma-Ata, USSR). Radiobiologiya; 9: 373-7(1969). (In Russian).

The activity of catalase and succinic dehydrogenase, as well as the concentration of cytochrome C, 6, 12, 24, and 48 hrs after whole-body x-irradiation, were studied in the liver, spleen, kidneys, brain, lungs, and cardiac muscle of rats of the Wistar line and guinea pigs. It was established that under the action of radiation there is an increase in the content of cytochrome C and a decrease in the catalase activity. The succinic dehydrogenase activity is elevated in the liver, brain, and lungs of the irradiated animals and is inhibited in the kidneys and cardiac muscle. (tr-auth)

9759 MATERIALS FOR STUDYING THE ROLE OF AUTOANTIBODIES DURING RADIATION DAMAGES INDUCED BY THE ACTION OF INTERNAL IRRADIATION. Shubik, V. M.; Nevstrueva, M. A.; Zapol'skaya, N. A.; Lavrent'ev, L. N.; Fedorova, A. V. (Scientific Research Inst. of Radiation Hygiene, Leningrad). Radiobiologiya; 9: 378-82(1969). (In Russian).

Under the action of a mixture of radioisotopes of the rare earth and alkaline earth groups, in the case of daily intake of the isotope in concentrations of 15 and 1.5 μCi per rat, autoantibodies for tissues of the kidneys and liver appear in the injured animals, the content of histamine and acetylcholine is increased, and phase fluctuations in the cholinesterase activity and destructive changes in the parenchymatous organs are detected. The disturbance of the enzymatic function of the liver develops before the detection of autoantibodies in the serum of the treated animals. The appearance of autoantibodies precedes the development of morphological changes in the liver and kidneys. Some parallelism was noted between the content of autoantibodies in the serum and histamine and acetylcholine in the serum and tissues of the animals. (tr-auth)

9760 CONTENT OF FREE RADICALS IN THE TISSUES OF RATS IRRADIATED WITH γ-RAYS AND FAST NEUTRONS. Gaziev, A. I.; Nikolaev, A. I.; Akhmadieva, A. Kh.; Kiv, I. I. (Scientific Research Inst. of Roentgenology, Radiology, and Oncology, Tashkent). Radiobiologiya; 9: 441-4(1969). (In Russian).

The dynamics of free radicals in the liver, spleen, and blood of rats irradiated with γ-rays at doses of 400 and 800 R and with fast neutrons at a dose of 500 rad, as well as in the case of local irradiation of the pelvic region and limbs with γ-rays at a dose of 2000 R were studied by the EPR method. Irradiation at a dose of 800 R produces a distinct increase in the free radical concentration in the liver and spleen during the first hours after irradiation and a decrease after 24 to 48 hrs. Local irradiation produces an analogous change in the concentration of free radicals, which once again emphasizes the metabolic nature of the observed changes. (tr-auth)

9761 INFLUENCE OF LOCAL IRRADIATION OF THE HEART REGION WITH HARD BREMSSTRAHLUNG WITH MAXIMUM ENERGY 4.3 MeV ON THE ENZYME ACTIVITY OF THE PROTEINS OF THE RABBIT CARDIAC MUSCLE AND BLOOD SERUM. Mochalova, I. N.; Mikhaleva, N. P.; Ivanov, I. I. (Military Medical Academy, Leningrad). Radiobiologiya; 9: 363-6(1969). (In Russian).

The influence of local irradiation of the heart region of a rabbit was studied using a linear accelerator (5 krad). A sharp increase in the activity of LDH, ALD, and CK, accompanied by pronounced morphological changes of a focal character in the tissue of the myocardium, was detected 60 hrs after the influence. However, no significant decrease in the activity of these enzymes could be detected in the sarcoplasmic proteins of the cardiac muscle. A change in the isoenzyme spectrum of LDH in the blood serum of the irradiated animals was demonstrated. (tr-auth)

9762 CONTENT OF NORADRENALIN AND ADRENALIN IN THE TISSUES OF MACAQUES THAT DIED OF ACUTE RADIATION SICKNESS. Kulinskii, V. I.; Semenov, L. F. (Inst. for the Advanced Training of Physicians, Karkov. Inst. of Experimental Pathology and Therapy, Sukhumi, USSR). Radiobiologiya; 9: 444-7(1969). (In Russian).

The content of noradrenalin (NA) and adrenalin (A) was determined among monkeys that died on the 6th to 21st days after irradiation with γ-rays at doses of 620 and 722 R. A substantial decrease in the content of A in the adrenals and of NA in the heart, spleen, liver, and brain stem was observed. These changes are evidence of relative insufficiency of the sympathico-adrenal system. A correlation was detected between the level of catecholamines in the tissues of the monkeys that died within definite functional portions of the sympathico-adrenal system: stem, mediator, and hormonal. (tr-auth)

9763 EVALUATION OF THE FUNCTIONAL STATE OF THE HYPOTHALAMUS AND CEREBELLUM DURING THE EARLY PERIODS AFTER THE INFLUENCE OF IONIZING RADIATION BY METHODS OF INDUCED POTENTIALS AND HIGH-FREQUENCY STIMULATION. Smirnova, N. P. (Inst. of Medicobiological Problems, Moscow). Radiobiologiya; 9: 399-406(1969). (In Russian).

The ability of the neuronal systems of the hypothalamus and cerebellum for adequate reception and processing of afferent signals, as well as the nature of the influence of the hypothalamus (method of high-frequency stimulation) on the function of the cerebellum, were evaluated in acute experiments on white rats. During the early periods (1–5 h) after total γ-irradiation at a dose of 700 R, changes were detected in the electrical responses of the cerebellar cortex to stimulation of the sciatic nerve. The receptor function of the hypothalamus is entirely preserved at this time. Among irradiated rats, a weakening of the inhibitory influence and some intensification of the facilitating influences of the hypothalamus on the induced activity of the cerebellar cortex are detected. (tr-auth)

9764 EFFECTS OF γ-RADIATION ON THE BASES, SUGAR PHOSPHATE CHAINS, AND HYDROGEN BONDS OF DNA OF VARIOUS TYPES IN AQUEOUS SOLUTIONS. Krushinskaya, N. P.; Shal'nov, M. I. (Inst. of Biophysics, Moscow). Radiobiologiya; 9: 229-345(1969). (In Russian).

The decomposition of bases, formation of malonic dialdehyde as

a result of damage to the deoxyribose residue of DNA, liberation of inorganic phosphate, and the appearance of cleavages of hydrogen bonds in native DNA and DNA partially denatured before irradiation, were investigated in irradiated 0.006% aqueous solutions of DNA isolated from chick erythrocytes, calf thymus, and rat liver. The radiobiological significance of the radiation chemical reactions studied was discussed. (tr-auth)

9765 STUDY OF FREE RADICAL STATES IN DNA BY THE EPR METHOD IN LOW-TEMPERATURE RADIOLYSIS. Golikov, V. P.; Trofimov, V. P.; Kalmanson, A. E. (Inst. of Virology, Moscow. Inst. of Chemical Physics, Moscow). Radiobiologiya; 9: 346-54(1969). (In Russian).

The formation of free radicals in native, denatured, and apyrimidine DNA and rRNA during low-temperature radiolysis was studied by the EPR method. On the basis of an analysis of the shape of the EPR spectra, the curves of accumulation of radicals, and the values of the radical yields, a number of conclusions were drawn on the nature of the paramagnetic centers in these compounds. It was shown that in impure preparations, the unpaired electrons are localized on impurities during radiolysis. (tr-auth)

9766 INVESTIGATION OF THE SH-GROUP CONTENT IN THE SPINAL CORD OF INTACT AND IRRADIATED ANIMALS. Reva, A. D.; Alferov, A. N. (Dnepropetrovsk State Univ., USSR). Radiobiologiya; 9: 411-15(1969). (In Russian).

It was shown by the method of amperometric titration that the tissues of the spinal cord of normal cats are arranged as follows in order of decreasing amount of SH-groups: gray matter of the posterior, anterior, and lateral horns, white matter, posterior and anterior roots. Whole-body irradiation at doses from 0.6 to 10 kR do not produce any significant changes in the content of SH-groups in the indicated regions of the cat brain during a two-day period; however, their content in the blood is substantially reduced. (tr-auth)

9767 EFFECT OF ULTRAVIOLET IRRADIATION ON THE BLOOD HAEMOGLOBIN OF MICE. Artyukhov, V. G. (Voronezh State Univ., USSR). Biophysics (USSR) (Engl. Transl.); 14: 202-4(1969).

Translated from Biofizika; 14: 189-91(1969).

The absorption spectra of hemoglobin (Hb) and oxyhemoglobin (HbO_2) irradiated with longwave and integral ultraviolet irradiation and the degree of splitting of hemoglobin were investigated. (auth)

9768 BIOSYNTHESIS OF ADENOSINETRI-, ADENOSINEDI-, AND ADENOSINEMONOPHOSPHORIC ACIDS IN THE NUCLEI OF THE RAT THYMUS DURING EARLY PERIODS AFTER WHOLE-BODY IRRADIATION. Romantsev, E. F.; Kolesnikov, E. E.; Khalikov, S. K.; Zhulanova, Z. I. (Inst. of Biophysics, Moscow). Radiobiologiya; 9: 433-6(1969). (In Russian).

It was found that in the case of incubation of thymus nuclei from control and irradiated rats with glycine-1-^{14}C, labeled AMP, ADP, and ATP are formed. A sharp disruption of the dynamic equilibrium among AMP, ADP, and ATP in the thymus nuclei of the animals was demonstrated 3 and 30 min after whole-body γ-irradiation at a dose of 1000 R. (tr-auth)

9769 BIOLOGICAL EFFECTS AND KINETICS OF THE ELIMINATION OF TRITIUM OXIDE IN DOGS. Zhuravlev, V. F.; Kalyazina, N. S.; Kalistratova, V. S.; Kryuk, V. F.; Shal'nova, G. A.; Kuz'mina, T. D.; Kodolova, L. I.; Kazbekova, D. A. (Inst. of Biophysics, Moscow). Radiobiologiya; 9: 450-1(1969). (In Russian).

The work presents data on the clinical picture of injury of dogs by tritium oxide. A leading place in the biological effects on the organism is occupied by changes in the blood system, which are characterized by an inhibition of leuko- and erythropoiesis. Pronounced changes in the fat and carbohydrate metabolism and a decrease in the synthetic function of the liver are detected in the animals. An inhibition of the immunological reactivity was noted among all the animals. The elimination of tritium oxide from the organism proceeds most intensively (up to 90% of all the activity introduced) during the first five to seven days. (tr-auth)

9770 FLUORESCENCE OF SERUM AND URINE FROM RATS EXPOSED TO MIXED GAMMA-NEUTRON RADIATION. Skidmore, Wesley D.; McHale, Carolyn G. (Armed Forces Radiobiology Research Inst., Bethesda, Md.). Radiat. Res.; 38: 357-64(May 1969).

Fluorescence intensity of serum and urine in rats exposed to mixed gamma-neutron radiations was evaluated for dose-dependent changes. Male Sprague-Dawley rats were exposed to doses in the range from 570 to 30,000 rads. Sera and urines were collected six, 12, 24, 48, and 72 hours after exposure. Emission spectra of diluted sera and urines were measured with a spectrophotofluorometer, and two peaks in the emission spectra of each were studied. A maximal change in fluorescence intensity of sera at 465 nm with exciting light at 350 nm occurred 24 hours after irradiation. The fluorescence intensity decreased with dose in the range from 570 to 9300 rads. An increase in fluorescence intensity at 360 nm (exciting light, 295 nm) occurred 72 hours after doses of 4700 or 9100 rads, but it was not shown to be dose-dependent. In urine, the fluorescence intensity at 425 nm (exciting light, 345 nm) increased as a function of dose in the range from 1000 to 30,000 rads. The intensity at 400 nm (exciting light, 295) did not change with dose. The results indicate that the changes in fluorescence intensities of sera at 465 nm and of urines at 425 nm from irradiated rats show limited usefulness as biological dosimeters. (auth)

9771 PROTEIN FRACTIONS AND SULFHYDRYL GROUPS IN EHRLICH'S ASCITES CARCINOMA CELLS WITH SECONDARILY INCREASED RADIORESISTANCE. Efimov, M. L.; Mironenko, N. I. (Scientific Research Inst. of Oncology and Radiology, Alma-Ata, USSR). Radiobiologiya; 9: 359-62(1969). (In Russian).

An increased percent content of albumin and α_1-globulin was detected in cells of a radioresistant subline of Ehrlich's ascites carcinoma, produced by repeated x-irradiation in vivo before each transplantation, in comparison with the original (radiosensitive) tumor. After massive irradiation, the changes in the ratios of the individual fractions in the original tumor were more pronounced than in the radioresistant tumor. In the cells of the radioresistant subline, the content of sulfhydryl groups of the soluble proteins was also significantly elevated, and this increase was maintained after massive irradiation of the original carcinoma and its radioresistant subline. (tr-auth)

9772 A RADIOBIOLOGICAL STUDY OF THE REPLICATION OF NEWCASTLE DISEASE VIRUS AND OF INTERFERON FORMATION IN VITRO. Coppey, Jacques; Markovits, Paul (Institut du Radium, Paris). Int. J. Radiat. Biol.; 16: 129-45(1969).

In monkey kidney cells, the production of interferon induced by Newcastle disease virus is closely related to the viral multiplication. The capacity of the viral production is highly uv-radioresistant as compared with that of the interferon production. The latter is an exponential function for doses up to 500 ergs mm^{-2}. The radiosensitivity of the viral production decreases during the lag time of its cycle. This phenomenon is blocked by puromycin but not by actinomycin D. The radiosensitivity curve of the interferon production, similar to that of the sensitivity to actinomycin D, shows three steps: (a) between 1 and 4 hours after infection, there is the high radiosensitivity of cellular DNA which codes for the messenger RNA of interferon; (b) between 4 and 12 hours the radiosensitivity decreases; (c) and reaches a plateau after 12 hours. Various experimental data suggest that this very low radiosensitivity is a measure of the sensitivity of the ribosomal process of the interferon formation. (auth) (UK)

9773 ON THE EFFECTS OF X IRRADIATION ON TRYPTOPHAN PYRROLASE AND NAD. Tenconi, L. T.; Nicolis, F. B. (Laboratori della Direzione Centrale Medica e della Ricerca Clinica, Milan). Acta Vitaminol. Enzymol.; 23: 9-13(1969). (In Italian).

The effects of x rays on tryptophan pyrrolase were studied by determining the enzymatic activity in the liver, and also indirectly through the urinary elimination of kynurenine. The results in several species of animals were compared on the basis of whole-body doses of x rays ranging from 500 to 1000 R. The increase observed in the liver of normal rats was not confirmed in experiments with mice, in which, moreover, a fall of the nicotinamide-adenine dinucleotide (NAD) levels due to irradiation was recorded. From a review and a critical evaluation of all the available data, it seems unlikely that irradiation may produce opposite effects in different animal species. It is therefore suggested that these differences in results may be better explained by differences used in the experimental conditions, and by the complexity of the problem of which one aspect only is evaluated in these experiments. The relations of this enzyme with pyridine nucleotides are becoming increasingly better known, while the multiplicity of the interferences between the reaction mechanisms, as well as the difficulty of correlating effects due to abnormal stimuli, such as those achieved with irradiation of lab animals, are gradually being revealed. The demonstration of latent tryptophan pyrrolase states which may be activated by diverse activators, and give rise to different forms of enzymes, makes the problem even more complicated. (BBB)

9774 KREBS CYCLE DEHYDROGENASE SYSTEMS ACTIVITY IN THE GASTROINTESTINAL TRACT OF RATS AFTER WHOLE-BODY IONIZING IRRADIATION. Kivy-Rosenberg, Evelyn (Armed Forces Radiobiology Research Inst., Bethesda, Md.). Radiat. Res.; 40: 317-29(Nov 1969).

Using a tetrazolium salt (INT), three of the Krebs cycle dehydrogenase systems were studied in homogenates of four regions of the gastrointestinal tract of the rat following either x-rays or mixed gamma-neutron radiation (in the G-I death dose range) delivered to the whole body (WBR). Microchemical assays were done at intervals after irradiation (10 to 20 minutes, 1, 2, and 3 days). There was a fall in activity as early as 10 to 20 minutes post-irradiation which increased in magnitude by the second and third day, for all regions studied. The gamma-neutron irradiations were relatively more effective than were the x-rays in bringing about this depression in malate-, succinate- and isocitrate-dependent dehydrogenase activity. These studies clearly indicate that the activity of the three assayed Krebs cycle dehydrogenase systems in these regions of the gastrointestinal tract was below normal after exposure to whole-body radiation. The functional capacity of the Krebs cycle appears impaired which may account, in part, for some of the functional derangements seen in such animals. (auth)

9775 TOXICITY OF IRRADIATED p-HYDROXYMERCURIBENZOATE. Bruce, A. K.; Mahoney, G. F.; Thomas, C. C. Jr. (State Univ. of New York, Buffalo). Western New York Nuclear Research Center, Buffalo). Contract AT(30-1)-3319. Radiat. Res.; 40: 298-309(Nov 1969).

The sensitization of bacteria to ionizing radiation by p-hydroxymercuribenzoate is through the formation of a toxic radiolytic decomposition product. The toxic agent has been identified as mercuric ion through comparison of rates and amounts of binding determined by neutron activation analysis and rate of development and amount of lethality produced in Micrococcus radiodurans. The amount deduced in these biological assays is in agreement with the yield of mercuric ion from irradiated ^{203}Hg labeled p-chloromercuribenzoate as determined by chromatography. Chromatography of the irradiated agent after incubation with the bacterium shows an uptake of only the mercuric ion component. The toxic response is greatest when the cell concentration is below that where total binding of mercuric ion to the cells occurs. Removal of at least a part of the bound mercuric ion and p-hydroxymercuribenzoate may occur into sulfhydryl containing agents such as 2-mercaptoethylamine or growth medium. Presumably this may also occur on plates yielding a variable division delay of cells treated with these mercury compounds. (auth)

9776 THE EFFECT OF VARIOUS DOSES OF IONIZING RADIATION, APPLIED UNDER DIFFERENT TEMPERATURE CONDITIONS, UPON LYSOSOMAL MEMBRANES OF THE LIVER CELLS, IN VITRO. Kalczak, M.; Sieinski, W.; Grochowska, Alicia (Military Medical Academy, Warsaw). Folia Histochem. Cytochem. (Krakow); 7: 59-62(1969).

The effects of x radiation applied in doses from 500 to 1500 R, under different temperature conditions, upon the permeability of lysosomal membranes of cultured liver cells, were studied. The permeability of these membranes for acid phosphatase was found to depend on the applied dose of radiation and the temperature at which the experiments were carried out. (auth)

9777 THE EFFECT OF X-IRRADIATION ON THE RELEASE OF LACTATE DEHYDROGENASE FROM ISOLATED THYMOCYTES OF MICE. Takamori, Yasuhiko; Takeda, Atsuhiko; Hori, Yasuharu; Nishio, Kazuo (Radiation Center of Osaka Prefecture, Sakai, Japan). Radiat. Res.; 38: 551-9(Jun 1969).

Isolated thymocytes and erythrocytes of mice were incubated at 37°C in calcium-free Krebs–Ringer phosphate buffer for 6 hours after x irradiation. The activities of lactate dehydrogenase (LDH) released into the surrounding medium and of that enzyme remaining within the cells were determined at various intervals of incubation. The release of LDH from the thymocytes exposed to 100 R of x radiation remained unchanged during the first 3 hours of incubation but thereafter increased markedly as compared with that from the control cells. This radiation-induced release of LDH ran almost parallel with an increasing number of dead cells, as identified by the differential staining with erythrosin B. The loss of LDH from the thymocytes increased with increasing dose up to 600 R, but showed no further increase with doses above 600 R. In the case of erythrocytes, there was no significant difference in the release of LDH and hemoglobin between unirradiated and irradiated cells. The liberation of LDH from erythrocytes seemed to be closely related to hemolysis. It was concluded that x irradiation caused the release of soluble proteins including LDH from thymocytes and that this early release would be derived mainly from dead cells. (auth)

9778 THERMOLUMINESCENCE IN COMPLEX BIOCHEMICALS: A POSSIBLE CORRELATION WITH RADIOSENSITIVITY. Cervigni, T.; Bassanelli, C.; Caserta, G.; Laitano, R. F. (CNEN, Rome). Radiat. Res.; 38: 579-87 (Jun 1969).

A correlation between thermoluminescence yield and the mean lethal x radiation exposure of some plant seeds is described. The results of thermoluminescence measurements on the main classes of seed components are also reported. These results seem to indicate that the physical interactions among fatty acids cause, in the species studied, different ability to retain energy. A possible connection between the last observation and the radiosensitivity of species is discussed. (auth)

9779 ROLE OF SUBSTRATES IN THE IRRADIATION OF ENZYMES. Arnaud, Y.; Coelho, R. (CEN de Saclay, Gif-sur-Yvette, France). Bull. Soc. Chim. Biol., 51: 275-82(June 26, 1969). (In French).

The effect of ionizing radiation on two different enzymes irradiated without or with their substrate was compared. A ^{60}Co source was used to give a radiation intensity of 3×10^4 rad/hr. Irradiation was carried out at 0°C. One of the enzymes tested was polyphenol oxidase (tyrosinase), which is a globular protein, and the substrate used was tyrosine. Actomyosin, a fibrous protein, with adenosine triphosphate (ATP) as substrate, was also irradiated. With the first enzyme, the action of radiation led to the hydroxylation of a fraction of tyrosine by free radicals; the by-product (DOPA) behaved like a radioeffector and activated tyrosinase. The substrate had a radioprotective action with actomyosin; in fact, the enzyme-substrate complex showed much more resistance than the enzyme alone. If ATP was added after the irradiation of actomyosin, it induced, by depolymerization, a restoration of the macromolecule that had become cross-linked by irradiation. In both instances the subunit structure of protein must be taken into account to explain the important role of substrate in the mechanisms of action of irradiation on enzymatic systems. (BBB)

9780 EFFECTS OF WHOLE-BODY X IRRADIATION ON ENZYMES IN MOUSE LIVER PEROXISOMES. Kleinbergs, Skaidrite. Ann Arbor, Mich., Univ. of Michigan, 1968. 100p. Thesis.

The effects of whole-body x irradiation on enzymes in mouse liver peroxisomes were investigated. Mice were exposed to a total dose of 800 R at a dose rate of 15 R per min. Animals were killed by decapitation beginning at 2 hr post irradiation up to 1 week after exposure. Of the enzymes contained in mouse liver peroxisomes, catalase and alpha-hydroxy acid oxidase were studied and the following parameters were investigated: variability in the total activity of the component enzymes, changes in subcellular distribution of enzymatic activities, and changes in physical properties of the subcellular particles. The distribution of cell particulates after differential centrifugation and density gradient centrifugation were determined by enzyme assays, using succinic dehydrogenase to mark mitochondria, acid phosphatase to indicate lysosomes, and lactic dehydrogenase as a marker for the soluble phase. From the data obtained it can be concluded that: Catalase activity decreases with time after irradiation. The observed rate and degree of inactivation depend on measuring techniques employed. Alpha-hydroxy acid oxidase activity initially increases after irradiation (24 to 72 hr), and returns to normal levels by 4 to 5 days post exposure. The three marker enzymes, succinic dehydrogenase, acid phosphatase, and lactic dehydrogenase, remained unaltered up to 3 days post irradiation. Intracellular localization of all mouse liver enzymes tested remained unchanged after irradiation as determined by differential centrifugation analysis. The evidence suggests that alpha-hydroxy acid oxidase from mouse liver may be associated with the peroxisomes on the basis that the distribution profile obtained is unlike that of lysosomes or mitochondria. The enzyme also displays similar substrate characteristics to an enzyme described in the peroxisomes of rat hepatic tissue. (Diss. Abstr.)

9781 THERMOLUMINESCENCE IN COMPLEX BIOCHEMICALS: A THEORETICAL APPROACH. Caserta, G.; Laitano, R. F.; Cervigni, T. (CNEN, Rome). Radiat. Res.; 38: 588-97(Jun 1969).

The thermoluminescence theories developed for inorganic substances are applied to analyze the glow curves of some plant seeds and seed components. It is shown that the theoretical glow curves, derived from the first-order theory, agree very well with the experimental ones. Nevertheless, a discrepancy is found concerning the values of the so-called frequency factor. For many of the examined substances the frequency factor had very low values. In these cases, it was not possible to give to the frequency factor the same meaning as in the Randall and Wilkins theory. A probable arrangement of the electronic levels involved in the thermoluminescence of the lipid components of seeds is given in the configuration coordinate diagram. (auth)

Immunology

Refer also to abstract 9914.

9782 INFLUENCE OF PENTOXYL ON THE ANITBODY-SYNTHETIC ACTIVITY OF LIVER AND SPLEEN EXPLANTATES OF IRRADIATED ANIMALS. Zolotnikova, G. P. (Kursk Medical Inst., USSR). Radiobiologiya; 9: 383-7(1969). (In Russian).

The peroral administration of pentoxyl is accompanied by elevated titers of immune globulins in the serum of irradiated and immunized rabbits. Pentoxyl, administered during the period of immunization, stimulates the antibody synthetic activity of liver and spleen explants of the irradiated animals. The stimulating influence on agglutinin synthesis by liver explants of irradiated rabbits, both of the experimental and of the control groups, was exerted under in vitro conditions by the addition of choline, glucose, or ATP to the nutrient medium. (tr-auth)

9783 THE NATURE OF THE EXCISION-REPAIR REGION IN THE DNA FROM A EUCARYOTIC ORGANISM, TETRAHYMENA PYRIFORMIS. Brunk, Clifford F.; Hanawalt, Philip C. (Stanford Univ., Calif.). Contract AT(04-3)326-7. Radiat. Res.; 38: 285-95(May 1969).

Repair replication of damaged DNA in ultraviolet-irradiated Tetrahymena pyriformis has been studied by CsCl density-gradient analysis of DNA synthesized in the presence of 5-bromodeoxyuridine. An improved method for the detection of repair is described, in which the amount of repair is examined in DNA segments that have replicated normally after the irradiation. Characterization of repair regions indicates that only a small fraction of the DNA fragments contain such regions and that the average length of the substituted regions in repaired DNA fragments is about 5000 nucleotides. Excision-repair in this system exhibits a selective utilization of thymidine over 5-bromodeoxyuridine similar to that reported for E. coli. The excision repair process appears to be completed well before the normal synthesis of DNA resumes. (auth)

9784 BEHAVIOR OF MARROW STEM CELLS IN IRRADIATED AND NON-IRRADIATED MICE AFTER TREATMENT WITH CYTOTOXIC AGENTS. Berman, Irwin; McCabe, Barry; Dauer, Maxwell M. (Univ. of Miami School of Medicine, Coral Gables, Fla.). Radiat. Res.; 38: 296-306(May 1969).

Treatment of murine marrow with triethylenethiophosphoramide, triethylenemelamine, Myleran, or urethan severely depresses the ability of bone marrow to form spleen colonies in heavily x irradiated mice. No age difference was observed with respect to the effects of urethan pretreatment of 30- and 90-day-old animals in this regard. Myleran and thio-TEPA, while inhibiting spleen colony-forming ability, were without effect on erythropoiesis in donor animals. These results were compared with results obtained from other studies in which these drugs, particularly urethan, were used to determine marrow's ability to promote thymic regeneration, prevent tumor formation, and prevent lethal irradiation death. The different results obtained in these experiments lead to the conclusion that the spleen colony-forming cell of marrow does not perform these functions. (auth)

9785 NONSPECIFIC SEROLOGICAL REACTIONS IN THE CASE OF DAMAGE TO THE ORGANISM BY ^{210}Po. L'vitsyna, G. M.; Shishkin, V. F. (Inst. of Biophysics, Moscow). Radiobiologiya; 9: 388-92(1969). (In Russian).

To determine the specificity of serological reactions in guinea pigs after the administration of ^{210}Po (5 μCi/kg), we investigated three groups of animals: group one was immunized with Breslau's vaccine one month before the administration of Po; group two was immunized two weeks after it; group three was left unimmunized. Antibodies for Breslau's vaccine, tetravaccine, and brucellosis diagnosticum were determined in the serum of the animals. The administration of ^{210}Po induced the appearance of nonspecific serological reactions in 56% of the guinea pigs. In the case of vaccination before the administration of Po, the number of nonspecific responses was five to ten times lower, and in the case of vaccination two weeks after the administration of Po, two to five times lower than for nonimmunized irradiated animals. (tr-auth)

9786 CELLULAR DIFFERENTIATION IN THE THYMUS. CHANGES IN SIZE, ANTIGENIC CHARACTER, AND STEM CELL FUNCTION OF THYMOCYTES DURING THYMUS REPOPULATION FOLLOWING IRRADIATION. Order, Stanley E.; Waksman, Byron H. (Yale Univ., New Haven). Transplantation; 8: 783-800(Dec 1969).

In Lewis rats, irradiated (900 R) and given syngeneic or (Lewis × BN) F_1 bone marrow, cellular repopulation of the thymus, lymph nodes, and Peyer's patches was studied by conventional histological methods, by analysis of expressed cell suspensions with an electronic particle counter, and by an immunofluorescence technique for identifying histocompatibility and thymus-specific antigens. Cells of bone marrow origin (bearing the BN antigen) first appeared in the thymus at 4 days. In the subsequent 4-day period, the total number of thymus cells began to rise rapidly. At first, a high proportion were large or medium sized cells in which BN antigen could be detected; these made up almost one-half of the thymus cell suspensions in some animals at 6 days. By 8 days, small thymocytes, lacking either BN or Lewis antigen detectable by immunofluorescence, had largely replaced these larger cells. Both small and large cells possessed a thymus-specific antigen demonstrable by immunofluorescence. The 8-day pattern was comparable to that seen in normal rat thymus. Bone marrow-derived cells appeared in the lymph nodes at 6 days and in large numbers only several days later. In the Peyer's patches, they were first seen at 11 days. Cells taken from the repopulated thymus at 6 days and injected into partially irradiated recipients homed in the irradiated bone marrow in considerable numbers. Their ability to return to marrow fell off rapidly after 6 days. Their progeny in the marrow were all lymphocytic (i.e., not erythrocytic, myelocytic, etc.). It was concluded that bone marrow-derived cells which repopulate the thymus have the ability to return to the marrow although they are unipotential, i.e., committed to a lymphocytic differentiation. They lose this ability as their size shifts from large to small and as histocompatibility antigen in their cell membrane diminishes below detectable levels and is replaced by thymus-specific antigen. (auth)

9787 LYMPHOID PRECURSORS: THYMUS INDEPENDENT ANTIBODY PRODUCTION. Tyan, Marvin L.; Herzenberg, Leonard A.; Gibbs, Priscilla R. (Naval Radiological Defense Lab., San Francisco. Stanford Univ. School of Medicine, Calif.). J. Immunol.; 103: 1283-7(Dec 1969).

Thymectomized and nonoperated adult mice were lethally whole-body x-irradiated and given liver cells from embryos of various ages. The resultant chimeras were hyperimmunized with sheep erythrocytes, and cell suspensions from their spleens were used in a hemolytic plaque assay employing specific anti-allotype antisera as developing agents in order to distinguish between cells producing host and donor-type γG_{2a} (7S) antibodies. It was found that lymphoid stem cells taken from embryos as early as the 10th day of gestation (i.e., before the appearance of the thymic rudiment) were able to produce γG_{2a} anti-SRBC antibodies in thymectomized hosts. The number of donor-type developed plaques found in the spleens of thymectomized hosts was approximately one-tenth that found in their nonoperated controls. Sensitization of the hosts to SRBC before irradiation and the transfer of embryonic liver cells did not increase the number of donor-type plaque-forming cells. (auth)

9788 ORIGIN OF ANTIBODY-FORMING CELLS FROM LYMPHOCYTES. Ellis, Susan T.; Gowans, J. L.; Howard, J. C. (Oxford Univ.). Antibiot. Chemother.; 15: 40-55(1969).

In rats given heavy doses of γ irradiation, small lymphocytes from the thoracic duct nonimmunized and immunized donors, respectively, conferred primary responsiveness to sheep erythrocytes and secondary responsiveness to tetanus toxoid. Most of the experiments employed highly inbred rat strains: AO (albino), HO (hooded), and DA (agouti) strains together with (AO × HO) and (HO × DA) F_1 hybrids. Fresh or incubated lymphocytes from the thoracic duct of normal (nonimmune) rats, together with 1 ml of 1% sheep erythrocytes, were injected intravenously into recipients which had received varying doses of radiation from a ^{60}Co source 24 hr previously. The titers of serum hemolysin and the number of plaque-forming cells (PFC) in the spleens were determined at various intervals after cell transfer. Small lymphocytes carrying immunological memory to tetanus toxoid could be stimulated with antigen in vitro. Macrophages were not essential for the induction of the secondary response. Control experiments with irradiated recipients showed that the transfer of immune cells yielded no response unless antigen was also injected and that cells from normal (nonimmune) donors conferred no reactivity to the challenging dose of antigen. Thus, irradiated rats acquired secondary responsiveness only after receiving cells from an immune donor. Use of antisera directed against the tissue antigens of the donor showed that the cells making antibody to sheep erythrocytes and to tetanus toxoid were the descendants of the injected lymphocytes. In these 2 immune responses in the rat the antigen-sensitive cells and the precursors of the antibody-forming cells were morphologically both small lymphocytes. The possibility that these 2 activities are performed by the same small lymphocyte is discussed. (BBB)

9789 THE EFFECTS OF CYTOSTATIC DRUGS AND X-RAY THERAPY ON THE FORMATION OF HEMAGGLUTINATION-

INHIBITING ANTIBODIES TO INFLUENZA VIRUS A PR 8. Neidhardt, Malte (Univ., Mainz). Z. Gesam. Exp. Med.; 150: 161-9(16 Jun 1969). (In German).

Effects of treatment with daily x irradiation, cyclophosphamide, amethopterin, or prednisolone on formation of hemagglutination-inhibiting antibodies were studied in rabbits and guinea pigs. The doses and patterns of administration were comparable to those used clinically. Irradiation doses amounted to 200 R daily given 3 or 5 days/week. A total of 20 irradiation treatments was given. The antibody titers of the animals for A PR8 influenza virus increased markedly immediately following administration of the antigenic treatments, and decreased somewhat from the fifth day after treatment was started. There was no significant depression of antibody titers within comparable dose ranges. Because of the immunodepressive effects of irradiation, it has been suggested that excessive irradiation treatment of tumors may produce more injury to immunogenic cells than tumor cells. It was concluded that this is not always true. (BBB)

9790 IMMUNOLOGICAL REACTIONS AFTER IRRADIATION OF THE UTERUS. Einhorn, Nina; Jonsson, Jonas; Fagraeus, Astrid (National Bacteriological Lab., Stockholm. Karolinska Institutet, Stockholm). Radiat. Res.; 40: 465-72(Nov 1969).

Antibodies to the mucosa of the portio and uterus were studied in 80 patients before and after intensive local irradiation by intracavitary application of radium. In addition, an examination was made of 30 apparently healthy women of the same age groups, who had not been submitted to irradiation. Antibodies to a cell line derived from a malignant uterine tumor were also examined in the sera from the patients, as were antibodies to thyroid cytoplasmic antigen, thyroglobulin, bovine gamma globulin, parietal cells and cell nuclei. Antibodies to the uterine tissues were observed before irradiation in some patients and also in some of the healthy controls. After intensive local irradiation there was a significant increase in antibodies to the epithelial cells of the portio and to the cervical gland cells. This increase would seem to be limited to antibodies to the irradiated tissue, since no increase in antibodies to any of various other tissues studied was observed. (auth)

9791 EFFECTS OF THYMECTOMY AND X-IRRADIATION ON THE IMMUNE RESPONSE OF MICE TO SHEEP ERYTHROCYTES. Takada, Akikazu; Takada, Yumiko; Ambrus, Julian L. (Roswell Park Memorial Inst., Springville, N. Y. State Univ. of New York, Buffalo). Radiat. Res.; 40: 341-50(Nov 1969).

Adult ICR/Ha mice were thymectomized or sham-thymectomized, and whole-body irradiation was given 10 days later. Hemolysin levels were determined in mice sacrificed 7 days after administration of sheep red blood cells (SRBC). When SRBC were given 24 hours to 6 months after irradiation with 400 or 500 R, hemolysin levels were lower in thymectomized mice than in sham-thymectomized mice. When SRBC were given 15 days after irradiation with 300 to 800 R, hemolysin levels returned to normal in sham-thymectomized mice, but decreased linearly in thymectomized mice as the radiation exposure increased. SRBC administration 1, 2, 4, or 5 days preceding irradiation with 400 R resulted in hemolysin titer curves showing little difference between thymectomized and sham-thymectomized mice. SRBC administration 24 hours following the same amount of radiation resulted in lower hemolysin titers and smaller numbers of direct and indirect plaques in thymectomized mice than in sham-thymectomized mice up to 13 days after irradiation; the differences between thymectomized and sham-thymectomized mice were smaller in both direct and indirect plaques at 20 days. (auth)

9792 REDUCTION OF IMMUNE RESPONSE IN RADIATION CHIMERAS: ATTEMPTS ON THEIR RESTORATION. Mathe, G. (Hopital Paul-Brousse, Villejuif, France); Nouza, K.; Hrsak, I.; Kolar, V. Antibiot. Chemother.; 15: 182-98(1969).

A summary is presented of clinical experience in transplantation of allogenic bone marrow cells, the incidence and character of various forms of secondary syndrome, as well as attempts to control this syndrome. Secondly experimental studies are reported on murine radiation chimeras used as a model system to investigate the immunological deficiencies and methods of treating this condition. Since 1956, allogenic bone marrow transplantation was attempted 24 times in man, mostly in patients suffering from acute lymphoblastic leukemia. The patients were given total-body ^{60}Co irradiation, the dose being divided into 2 sessions separated by 24 hr. Total dose varied between 800 and 950 rad. In 7 cases, the graft failed and six patients died. In 17 cases, the graft took; 13 patients died though they had been intensively treated for the secondary syndrome. In experimental animals, allogenic radiation chimeras were produced by lethal irradiation (950 rad), of young adult (CBA × C57Br) F1 mice, followed 4 hr later by the injection of 20×10^6 nucleated bone marrow cells from (DBA/2 × C57Bl/6) F1 donors. Fifteen to 20 days after irradiation, some chimeras chosen at random received a second injection of 30×10^6 living nucleated donor bone marrow cells. Survival at 60 days and immunological reactivity against sheep red blood cells (SRBC), allogenic skin grafts, Mycobacterium tuberculosis, and Candida antigen (at the 35th and 60th days) were compared in nontreated and treated animals. Untreated chimeras reacted only feebly to SRBC and skin grafts, whereas the reactions against mycobacterial and fungal antigens were essentially the same as in normal, nonirradiated mice. The second transfusion of donor bone marrow improved the 60-day survival, but had no effect on the immunological activity of chimeras. On the other hand, donor and third-party thymus grafts improved at least temporarily the immune responses of some grafted animals. Evidence was obtained that at least a temporary take of thymus grafts was necessary to achieve the lymphostimulating effect. A humoral factor seems to be involved more likely than the cellular migration of thymus cells to the lymphoid tissues. (BBB)

9793 BIOSYNTHESIS OF HUMAN PLACENTAL PROTEINS AND HUMAN PLACENTAL LACTOGEN (HPL) IN VITRO. II. DYNAMIC STUDIES OF NORMAL TERM PLACENTAS. Suwa, Seizo; Friesen, Henry (Royal Victoria Hospital, Montreal). Endocrinology; 85: 1037-45(Dec 1969).

Synthesis and release of human placental proteins and HPL were examined in six normal term placentas incubated with ^3H-l-leucine in vitro for up to 96 to 120 hr. The HPL content in fresh tissues was approximately 300 $\mu g/g$ wet weight. The amount of proteins and ^3H-proteins released into the medium was fairly constant among different placentas, while a variable release of HPL was noted in different placentas. The per cent of ^3H–HPL to ^3H-proteins in medium (5 to 10% in 4 placentas) was significantly higher than that in tissue (1 to 2%), indicating preferential or selective release of HPL. Two placentas showed an extremely high incorporation rate of ^3H-leucine into HPL, suggesting the possible existence of a biochemically abnormal placenta. Over 80% of the total synthesized ^3H-HPL was released into the medium within the first 24 hr incubation, while only 22% of the total ^3H-proteins was released in this period, suggesting a rapid rate of release of HPL. The specific activity of ^3H-HPL in medium was much higher when compared with that in tissue, while the ratio of specific activity of ^3H-proteins in medium to that in tissue was unity after a 24 to 48 hr incubation period. This result implies that there may be a stable tissue pool of HPL which is not as readily released as newly synthesized ^3H-HPL. A hypothetical scheme for the dynamic aspects of the biosynthesis and release of HPL is presented. (auth)

9794 BIOSYNTHESIS OF HUMAN PLACENTAL PROTEINS AND HUMAN PLACENTAL LACTOGEN (HPL) IN VITRO. I. IDENTIFICATION OF ^3H-LABELED HPL. Suwa, Seizo; Friesen, Henry (Royal Victoria Hospital, Montreal). Endocrinology; 85: 1028-36(Dec 1969).

Fresh human placental tissue was incubated with ^3H-l-leucine to study the biosynthesis of proteins and HPL in vitro. After gel filtration of tissue extract and incubation medium on Sephadex G-100, appropriate fractions were precipitated by anti-HPL. Two radioactive proteins of widely differing mol. wt. were precipitated; the larger radioactive proteins were determined to be greater than mol. wt. 100,000. The mol. wt. of the smaller radioactive proteins which were precipitated by anit-HPL was about 20,000. The radioactive protein of mol. wt. 20,000 precipitated by anti-HPL was identified as ^3H-HPL by immunological properties and electrophoretic mobility. The specificity and quantitative accuracy of the precipitation method used for measuring ^3H-HPL was evaluated. The nature of the large mol. wt. species precipitated by anti-HPL has not yet been defined. Although some histological modification of placental tissue cells was observed during the incubation period, glucose consumption and the incorporation of ^3H-leucine into proteins and HPL was fairly constant for at least 96 hr, confirming the metabolic integrity of the placental tissue. (auth)

Ecology

Refer also to abstracts 9598, 9746, 9751, 9824, and 9827.

9795 (BMI-171-20) BIOENVIRONMENTAL AND RADIOLOGICAL-SAFETY FEASIBILITY STUDIES, ATLANTIC–PACIFIC INTEROCEANIC CANAL: AGRICULTURAL ECOLOGY. Final Report. Gamble, John F.; Snedaker, Samuel C.; (and others) (Florida Univ., Gainesville. Inst. of Food and Agricultural Sciences). Sep 1969. Contract AT(26-1)-171. 212p. Dep. CFSTI. For Battelle Memorial Inst., Columbus, Ohio.

The agricultural ecology of the Panama and Columbia area, where a nuclear-excavated sea-level canal is proposed, was

studied. Following the preparation of soils maps and micromonoliths of the principal soil types, the soil clays were separated and radionuclide retention studies were performed on them. The results showed a very high capacity for radiocation sorption indicating that very little fallout radioactivity would be released to the ground water. Analyses of soil-extracts for elemental composition revealed P, K, Ca, Sr, Mg, Fe, Mn, Cu, and Zn by atomic absorption and W by neutron activation. Using regression equations and linear correlations, the elemental analysis data from the soil-extracts were compared with the corresponding crop samples from that soil type. The only significant regression found was rice manganese. In foliar application studies in which ^{134}Cs, ^{59}Fe, ^{85}Sr, and ^{185}W were applied to coconut palm and banana plants, ^{134}Cs was the only radionuclide transferred to the fruit; much more activity was found in bananas than in coconuts. Kinetic studies of ^{134}Cs on bananas revealed an equilibrium time of 20 days and an uptake curve indicating a first-order relation. Tissue samples from cattle, including heart, kidney, spleen, muscle, liver, and metacarple bone, produced in the study area were subjected to elemental analysis, and results of which were compared to forage analyses. Nutrients were low in forage, but the region in general is well adapted to cattle production. Compartmental analyses were performed to compare the rates of radionuclide uptake by second-growth crops. The importance of these studies lies in the fact that the population farming this area will be evacuated for 2 to 3 yr following the actual excavation leaving the land fallow. The bio-mass of the second-growth will constitute the nutrient for the first post-shot crop planted when the population returns to the area. Thus, the radionuclide uptake by this second-growth is as important as the uptake by the first post-shot crop. Radiotracer studies indicated that the uptake accumulation is probably first-order and may be controlled by the final stage. (E.R.B.)

9796 (CONF-690303) BIOLOGICAL IMPLICATIONS OF THE NUCLEAR AGE. Proceedings of a Symposium held at Livermore, California, March 5–7, 1969. AEC Symposium Series 16. (California Univ., Livermore. Lawrence Radiation Lab.). Dec 1969. 334p. Dep. CFSTI.

Separate abstracts were prepared for 15 of the 19 papers presented in this symposium. The four other papers appeared previously in NSA as abstracts: 23: 33836, 23: 41318, 23: 45434, and 23: 49977. Biological systems, ecosystems, environmental contamination, and nuclear medicine are discussed in terms of an expanding nuclear technology and increased applications of nuclear energy in industry. (E.R.B.)

For abstracts of individual papers see: 9751, 9797–9801, 9810, 9824, 9827, 9840, 9885, 9908, and 9922–9924.

9797 (CONF-690303–, pp 125-32) RADIOACTIVE POLLUTION OF THE ATMOSPHERE. Holland, Joshua Z. (Division of Biology and Medicine (AEC), Washington, D. C. Fallout Studies Branch).

Presently existing nuclear technology can expand for several decades at a maximum pace determined by supply and demand, while keeping the radioactive air pollution within acceptable limits. Presently known methods for improving existing technology can extend that period a few additional decades. But after that, if the peaceful applications of nuclear energy are to continue to expand at a rate commensurate with human needs, new methods will be required for industrial waste-gas handling and for evaluating the acceptability of proposed new sources of pollution. There is no reason to doubt that the science and technology can grow at a sufficient rate to be available when needed. (auth)

9798 (CONF-690303–, pp 133-43) REACTOR RELEASES OF RADIONUCLIDES. Junkins, R. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

The releases of radionuclides from reactors and the environmental effects of these releases have been studied since the early 1940's. Controls based on the knowledge gained from these studies were adequate to maintain the radiation exposure of the public well within acceptable limits. The significant pathways of exposure have been identified. Over the years, improved methods of radioactive waste treatment and containment technology for reactors have evolved to the point where release of waste heat from power reactors now appears to be receiving more public attention than the release of radionuclides. (auth)

9799 (CONF-690303–, pp 189-200) RADIONUCLIDES IN FOOD. Harley, John H. (New York Operations Office (AEC), N. Y. Health and Safety Lab.).

The significance of measurements of low levels of radionuclides in foods for locating critical items in the diet for a particular nuclide and for studies on the mechanisms of entry of the radionuclides into the food chain is pointed out. Composite samples of food purchased in New York, Chicago, and San Francisco were analyzed for ^{137}Cs, ^{226}Ra, ^{90}Sr, and U. Tables are presented to show relative contributions of the various diet components to ^{137}Cs intake in Chicago, and ^{226}Ra, ^{90}Sr, and U in New York and San Francisco. A comparison of ^{137}Cs and ^{90}Sr intakes by the human population of the United States and the USSR showed that the Soviet intake of ^{90}Sr was twice and the ^{137}Cs intake, three times that in the United States. (auth)

9800 (CONF-690303–, pp 201-16) STATUS OF REMEDIAL MEASURES AGAINST ENVIRONMENTAL RADIOCONTAMINATION. Comar, C. L.; Thompson, J. C. Jr. (Cornell Univ., Ithaca, N. Y.).

The general principles of remedial measures for radioactive contamination of the environment are reviewed, and the critical factors are examined (important radionuclides, foods, and population groups). Since ^{131}I is considered as the most critical radionuclide under normal operating or accidental situations, the primary remedial measures for this radionuclide were developed extensively. Models are shown that estimate total intake commitment from ^{131}I measurements in milk on any given day after the start of contamination. Methods to reduce this commitment are then discussed (stop drinking milk or remove cattle from pasture) along with the relative effectiveness of such measures. Other remedial measures relating to ^{90}Sr and ^{137}Cs are reviewed, particularly the effects of dietary additives (phosphate gels, alginates, and Prussian Blue) and modifications of human dietary patterns. The general philosophy is discussed in regard to the likelihood of conditions that would require implementation of remedial measures. It is pointed out that the situation most likely to require remedial measures, namely, ^{131}I contamination, can be coped with; the circumstances that cannot be handled technologically, significant long-term ^{90}Sr contamination, fortunately seem unlikely to occur. (auth)

9801 (CONF-690303–, pp 223-30) SOME BIOLOGICAL EFFECTS OF RADIATION IN RELATION TO OTHER ENVIRONMENTAL AGENTS. Nelson, Norton (New York Univ., N. Y. Inst. of Environmental Medicine).

The interactions between ionizing radiations and other environmental agents in causing hazards to man are not yet subject to orderly and quantitative presentation. The compartmentalization of research should be eliminated, and standards should be set on different environmental hazards, in order to recognize important and possibly synergistic interactions. Responses to radiation are interdependent with age, hormonal status, and other factors. Enzymatic processes that may be involved in defense against drugs or toxic compounds, can be affected by radiation exposure. Possible additive or synergistic effects of radiation and chemical mutagens in producing genetic or somatic mutations are little understood. Activation of latent viruses, which then produce tumors, can be evoked by either radiation or chemical agents. Carcinogenesis by radiation or chemical agents presumably comes about via similar pathways. The statistical outcome in tumor incidence may show either additivity of radiation and chemical effects or, perhaps, a synergistic action. The first reasonably clear demonstration in man of an interaction between radiation and a chemical carcinogen (tobacco) is seen in an enhancement of lung cancer incidence in uranium miners who smoke cigarettes. (auth)

9802 (ORNL-TM-2737) EIGHT-YEAR SUMMARY OF PLANT-SOIL DATA ON ^{137}Cs IN A TAGGED APPALACHIAN FOREST DOMINATED BY LIRIODENDRON TULIPIFERA. Peters, L. N.; Olson, J. S.; Anderson, R. M. (Oak Ridge National Lab., Tenn.). Dec 1969. Contract W-7405-eng-26. 235p. Dep. CFSTI.

A long-term tracer experiment using ^{137}Cs was initiated May 20-23, 1962. The experimental site was located on the AEC Reservation, Oak Ridge, Tennessee, in a forest dominated by tulip poplar (Liriodendron tulipifera). The trees in an area of 20 to 25 meters were tagged with 464 mCi of ^{137}Cs. In the autumn immediately after inoculation, approximately 63 percent had transferred to the ground (0 to 30 cm, including litter) inside and outside the tagged area. Rainfall accounted for four percent of total ground burden and litter fall about 12 percent; therefore, roots must have contributed approximately 84 percent of the cesium concentration in the soil. Almost all of the cesium was immediately bound within the soil. By 1967 the total amount accumulated in the soil and litter was 96% (±5% S.E.) of initial inoculum. Continuous sampling of canopy parts indicated a relatively steady decline of ^{137}Cs concentration in leaves. There was no evidence of recycling of ^{137}Cs from roots. Numerous amounts of data have been collected since the tagging of the forest. This report constitutes a depository of data on amounts and rates of transfer of ^{137}Cs in the tulip poplar forest. (auth)

9803 (ORO-3514-9) THE USE OF RADIOISOTOPES FOR STUDIES ON THE ECOLOGY OF TICK VECTORS OF DISEASE.

Fourth Annual Progress Report, April 1, 1969–January 1, 1970. Sonenshine, Daniel E. (Old Dominion Coll., Norfolk, Va.). Contract AT(40-1)-3514. 69p. Dep. CFSTI.

The ecology of ticks that are disease vectors was studied following the release of ^{14}C-labeled larvae in Virginia. Data are presented from field studies on the survival of immature stages; host-parasite relations, with emphasis on dispersion of ticks by small rodents; and the influence of vegetative associations on adult population dynamics of the dog tick, Dermacentor variablis, the lone star tick, Amblyomma americanum, and the Rocky Mountain wood tick, Dermacentor andersoni. Radioisotope labeling was found to be a very useful technique in the case of ticks with relatively abundant natural hosts, D. variables and D. andersoni, but not in the case of A. americanum. The potential usefulness of ^{90}Sr as a label for ticks and of double labeling with ^{14}C and ^{90}Sr for radioecological studies was demonstrated in laboratory studies. (C.H.)

9804 INFLUENCE OF CHRONIC IRRADIATION ON THE MICROFLORA OF THE SOIL OF A GAMMA FIELD. Kashkina, G. B.; Abaturov, Yu. D. (Inst. of Medical Radiology, Obninsk, USSR). Radiobiologiya; 9: 460-2(1969). (In Russian).

The influence of γ-irradiation on the species composition and population of microorganisms of the soil microflora was demonstrated as a function of the dose rate. A change in the structure of the microbiocoenosis was noted. (tr-auth)

9805 A DEMOGRAPHIC ANALYSIS OF CONTINUOUSLY IRRADIATED AND NONIRRADIATED POPULATIONS OF THE LIZARD, UTA STANSBURIANA. Turner, Frederick B.; Medica, Philip A.; Lannom, Joseph R, Jr.; Hoddenbach, Gerard A. (Univ. of California, Los Angeles). Contract AT(04-1)GEN-12. Radiat. Res.; 38: 349-56(May 1969).

A natural population of the lizard Uta stansburiana occupying a fenced 20-acre area in southern Nevada has been exposed to essentially continuous γ irradiation since February 1964. Tissue doses averaged about two rads/day. Nonirradiated populations occupying three adjoining 20-acre areas have also been investigated. Five years of sampling data drawn from the experimental and control populations showed no statistically significant differences in the sex ratios. Comparisons of maximal life span (44 months) and age distributions did not indicate a statistically significant difference between the experimental and untreated populations, but the tests were not sensitive to small changes in the proportions of individuals living to the age of 44 months. Both the 59% increase of the irradiated population between 1966 and 1967 and the 43% decline between 1967 and 1968 were generally matched by corresponding changes in the three untreated areas. (auth)

9806 SURVIVAL OF RATS AT ENIWETOK ATOLL. Jackson, William B. (Bowling Green State Univ., Ohio). Pac. Sci.; 23: 265-75(Jul 1969). (COO-1485-20).

The story of rats at Eniwetok Atoll (Marshall Islands) and their apparently uncanny ability to survive atomic detonations and inhabit areas with high levels of radiation is reviewed. The purpose of this paper is to pull together the fragments of data that are available and, at this late date, attempt to piece together the story of the survival of rat populations at Eniwetok. (auth)

9807 EFFECTS OF SOIL AND CROP MANAGEMENT PRACTICES ON THE REMOVAL OF ^{90}Sr BY PLANT UPTAKE, LEACHING, RUNOFF, AND EROSION. Haghiri, F. (Ohio State Univ., Wooster). Agron. J.; 61: 793-6(Sep-Oct 1969). (COO-414-9).

Long-term field investigations are being conducted to study the effect of management practices on the removal of ^{90}Sr by runoff, leaching, erosion and plant uptake. The management practices consist of one crop rotation with high and low rates of lime, permanent grass, continuous corn, and gravel mulch with no vegetation. Over a 5-year period, the ^{90}Sr content of the soil in a 0–10-cm depth decreased in all cropping systems. The percent ^{90}Sr loss by runoff water and sediment was negatively correlated with time while the percent ^{90}Sr in the leachate water increased with time. The percent ^{90}Sr removal by runoff and leachate water was maximum under gravel mulch and minimum under grass treatments. Sod crops were more effective in minimizing the ^{90}Sr loss in runoff and leachate water than cultivated crops. High Ca accumulating crops such as alfalfa removed more ^{90}Sr than low accumulators such as corn. High rates of lime reduced the ^{90}Sr uptake by crops and the removal by leachate water. (auth)

9808 STUDIES OF RADIOACTIVITY IN GRAPE VINES. Bulumac, P. (Institut Agronomique, Bucharest). Rev. Roum. Phys., 14: 287-301(1969). (In French).

Various parts of the grapevine (roots, foliage, raisin) as well as the soil from different depths and rainwater were analyzed for fission product fallout activity. The quantity of potassium was determined by flame photometry and was expressed in picocuries of ^{40}K per gram of ash or per kilogram of plant material. The beta activity was obtained by subtracting the ^{40}K content. The main beta activity was due to long-lived ^{90}Sr which was analyzed by oxalate precipitation. The results are given in picocuries of ^{90}Sr per gram of ash, per gram of Ca, or per kg of non-calcined sample. In addition, the presence of ^{144}Ce and ^{141}Ce, ^{137}Cs, ^{95}Zr and ^{95}Nb, ^{103}Ru, and ^{106}Ru was established by gamma spectrometry on a NaI(Tl) crystal having a resolution of 8.3% for the 661 keV gamma peak of ^{137}Cs. These activities are given in picocuries per gram of samples. The soil was found to contain Be, Ni, Mo, Co, and Cr as trace elements, as determined by ultraviolet spectrometry. Potassium was found to concentrate selectively in the raisin. The root of the grapevine concentrates potassium appreciably, but the other radioactivities are not accumulated. The quantity of potassium in the root decreases with depth. Radiocerium and radiocesium are present in the surface or shallow part of the root, while radiostrontium was encountered over the entire depth. The leaves showed the presence of relatively large amounts of potassium and of the other radioactive isotopes from fallout. Considerable contamination, especially ^{144}Ce, is absorbed through foliage surface. Wine dregs contain relatively large amounts of ^{40}K and other activities as insoluble salts. ^{137}Cs is retained firmly by the soil. The quantities of ^{90}Sr and other activities in the raisin are below the maximum allowable amounts established by AIEA. (TTT)

Genetics and Cytogenetics

Refer also to abstracts 9751, 9877, and 9969.

9809 (BNL-14197) EFFECTS OF THERMAL, MONOENERGETIC AND FISSION NEUTRONS ON NIGELLA CHROMOSOMES. Moutschen, J.; Moutschen-Dahmen, M. (Liege Univ. (Belgium). Brookhaven National Lab., Upton, N. Y.). [1969]. 18p. (CONF-691106-4). Dep. CFSTI.

From Symposium on Neutrons in Radiobiology, Oak Ridge, Tenn.

Nigella damascena seed was found to be highly radiosensitive. Dry seed irradiation results exclusively in aberrations of the chromosome class which is the only one investigated herein. The experiments with thermal and fission neutrons were performed at Brookhaven National Laboratory. The effects of the neutron irradiations were compared with those of ^{137}Cs γ rays for each kind of aberrations. RBE's were computed and found to be high in all cases being higher for two-break than one-break aberrations. Monoenergetic fast neutrons (0.43 MeV–1.8 MeV) were obtained from a Van de Graaff generator at BNL. The effects on Nigella chromosomes were inversely proportional to energy (a result comparable with the Ig_2 system in maize). The effects of monoenergetic neutrons were also analyzed for another criterion, i.e. frequency of radiation-induced polyploid cells and found to be comparable with chromosome breakage. The inverse relation of effects with neutron energy is discussed. Nonrandom distribution of chromosome exchanges was demonstrated and was related to the occurrence of sites. Exchanges were localized in the cases of γ rays and three neutron energies. Dicentrics scored at the first mitosis were correlated with symmetrical translocations observed at meiosis. Some genetical implications of this correlation are discussed. (auth)

9810 (CONF-690303–, pp 255-67) FACTORS AFFECTING THE RADIATION INDUCTION OF MUTATIONS IN THE MOUSE. Russell, William L. (Oak Ridge National Lab., Tenn.).

Research on the genetics of mice at the Oak Ridge National Laboratory is reviewed. Emphasis is placed on the specific gene locus method for testing the effects of physical and biological factors on the nature and frequency of radioinduced mutations in mice. The review is limited to those findings considered relevant to the estimation of genetic hazards of radiation for man. Rates of radioinduced mutations at seven gene loci tested varied more than 30-fold. There was a difference in distribution of induced rates of mutation in oocytes and in spermatogonia. Both sexes showed a marked effect of radiation dose rate on mutational frequency. Although spermatogonia did not exhibit a threshold dose rate for mutation induction, oocytes appeared to approach such a threshold at low doses. The comparative effects of fission neutrons and γ-x radiation on oocytes and spermatogonia are discussed. The departure from a linear relation between mutation frequency and dose suggests that low doses of radiation do not pose the genetic hazard previously anticipated. Other topics reviewed are dose fractionation, radiation quality, and effects of the interval between irradiation and conception on mutation frequency. The results indicate that, under some circumstances, mammalian germ cells can repair much of the mutational or premutational damage induced

by radiation. Thus the genetic hazard will be less per unit dose of radiation when the exposure is spread out in time, is delivered in small dosage, or when an interval occurs between a radiation of the female germ cells and conception. (auth)

9811 (NYO-3671-7) RADIATION-INDUCED CHROMOSOMAL INVERSIONS IN MOUSE POPULATIONS. Progress Report, November 29, 1968-November 28, 1969. Roderick, Thomas H. (Jackson Lab., Bar Harbor, Maine). 12 Dec 1969. Contract AT(30-1)-3671. 18p. Dep. CFSTI.

Inversions were detected in sperm of x-irradiated mice by observing the frequency of first anaphase bridges in meiotic cells of their sons. After screening 849 males, it was found that there were 21 animals with persistently high frequencies of anaphase bridges. The criteria for singling out an animal for propagation are discussed. In addition to the frequency of anaphase bridges, other diagnostic characteristics are the dispersion of bridges throughout the testis, a high frequency of telophase bridges, broken bridges, fragments, and some bridges of considerable length. Characteristics and inheritance of high frequency anaphase bridges are discussed. Comparisons were made of the length of bridges of some inversions. Advantages of biochemical markers for use in linkage analysis of inversions are discussed. (H.L.W.)

9812 THE STUDY OF CYTOLOGICAL CHANGES IN EGG-PLANT UNDER THE INFLUENCE OF X RAYS. Bagramyan, S. B. Biol. Zh. Arm.; 21: No. 7, 101-6(Jul 1968). (In Armenian).

The effects of x rays on the frequency of chromosome recombinations in eggplant (variety Erevanskii local and Delicates A-163) in relation to dose were studied. Following x irradiation of the seeds, the relation of fragments to bridges was changed in relation to dose and variety. With increasing dose, the percent of chromosome recombinations was increased. In both varieties the formation of bridges and single fragments was observed. Varietal specificity was observed in relation to the efficiency of the x rays. (tr-auth)

9813 THE INVESTIGATION OF THE ACTION OF RADIATION ON VARYING AGE SEEDS OF CREPIS CAPILLARIS. Batikyan, G. G.; Danielyan, A. Kh.; Martirosyan, S. N.; Karagezyan, A. S. (Inst. of Experimental Biology, Erevan). Biol. Zh. Arm.; 21: No. 11, 39-45(Nov 1968). (In Russian).

The mutagenic effects of ionizing radiation on dormant seeds was studied using meristematic cells and initial rootlets of anhydrous seeds of Crepis capillaris. Four groups of seeds (the harvest from 1963, 1964, 1965, and 1966) that were kept up to the time of irradiation in the same laboratory conditions were used. A dose of 4000R at a dose rate of 600R/min was applied. Metaphase structures were analyzed. The majority of aberrations found in the seeds were of the chromosome type, yet in nonirradiated seeds, the spectrum of aberrations was changed with age, i.e., in proportion to aging, recombinations of chromosome types predominated. Age had a greater effect on the chromosome types observed than did irradiation. However, in the dormant system, the probability of the realization of potential changes induced by ionizing radiation was increased with the age of the seeds. (tr-auth)

9814 THE EFFECTS OF 5-FLUORODEOXYURIDINE ON RADIATION-INDUCED CHROMATID ABERRATIONS IN TRADESCANTIA MICROSPORES. Rushton, Priscilla Strickland (Emory Univ., Atlanta). Contract AT(40-1)-2669. Radiat. Res.; 38: 404-13(May 1969).

Inflorescences of Tradescantia paludosa were treated with 5-fluorodeoxyuridine (FUdR) to test the effects of this compound on x radiation-induced chromatid aberrations. Treatment with 10^{-6} M FUdR during G_2 significantly reduced the chromatid exchange frequency but had no effect on the chromatid or isochromatid breaks. Treatment during S disturbed all three of the aberration frequencies and caused a 15-hour delay in the appearance of chromosome aberrations. When inflorescences were allowed to recover in water after FUdR treatment and before irradiation, the effects on the chromatid and isochromatid breaks were abolished with a 1.5-hour recovery period while the exchange frequency returned to the control level after three hours in water. (auth)

9815 DOSE-RESPONSE RELATIONSHIP FOR TRANSLOCATIONS INDUCED BY X-IRRADIATION IN SPERMATOGONIA OF MICE. Leonard, A.; Deknudt, Gh. (Nuclear Energy Study Center, Mol, Belgium). Radiat. Res.; 40: 276-84(Nov 1969).

Male BALB/c mice received local irradiation to the testes with exposures of 250, 500, 750, 1000, or 1250 R of x rays. Thirty weeks after treatment, the mice were killed, the testes were removed and used for cytological examination of spermatocytes. The chromosome rearrangements identified cytologically were all reciprocal translocations. The percentage of abnormal cells increases from 4.50% after 250 R to 7.29% after 500 R and confirms the linearity of the dose-response relationship up to 600 R. Reduction in the yield of translocations was recorded after higher x-ray doses presumably because of germinal selection. The x-ray kinetic data suggest that, at the dose levels used, the major proportion of chromosome rearrangements was produced by the passage of only one electron track and not by the interaction of two. (auth)

9816 THE INDUCTION OF AUXOTROPHIC MUTANTS OF MYCOBACTERIUM PHLEI P BY ULTRAVIOLET RADIATION. Konickova-Radochova, M.; Malek, I. (Inst. of Microbiology, Prague). Folia Microbiol. (Prague); 14: 251-3(1969).

A total of 98 auxotrophic mutants was obtained after uv irradiation of Mycobacterium phlei. Sixty auxotrophic mutants were isolated after using uv doses of 2500 erg/sec/mm^2 and higher, yielding a 5% or lower survival. The auxotrophic mutants obtained are described according to their nutritional requirements. Most common were mutants with a single amino acid requirement. In some cases, one amino acid could be substituted by another. A total of 83 mutants of this type was obtained. Most were mutants requiring glycine or serine (67), including those where glycine could be replaced by cystine or cysteine. Mutants requiring other amino acids were usually represented by only one or two strains. Three mutants were detected requiring components of nucleic acids, two of them requiring purines and one cytosine or uracil. Requirement for vitamins was the least frequent among singly auxotrophic mutants. There were two mutants of this type, one requiring pyridoxine and the other folic acid or vitamin B_{12}. A relatively high number of doubly auxotrophic mutants were isolated after uv treatment, requiring two amino acids, i.e., cysteine and glycine or serine (three mutants), one mutant requiring arginine and isoleucine, and one mutant requiring an amino acid and a pyrimidine (arginine and cytosine or uracil). Two mutants requiring three amino acids (cystine, leucine, and glycine or serine) were also detected. It was concluded that uv radiation is a suitable mutagen for the induction of auxotrophy in the PA strain of M. phlei from both quantitative and qualitative aspects. (BBB)

9817 CONGENITAL BODY MALFORMATIONS AND EYE COLOR MUTATIONS IN PROGENY FROM IRRADIATED FEMALE WASPS (DAHLBOMINUS). Baldwin, W. F. (Atomic Energy of Canada Ltd., Chalk, River, Ont.). Radiat. Res.; 38: 569-78 (Jun 1969).

Body malformations occurring in haploid male progeny from γ-irradiated Dahlbominus females are described, and the rises in frequencies with advancing maternal age and with chronic versus acute exposures are shown to resemble the corresponding relations for eye color mutations. This similarity in the two types of change, together with tests of the heritability of those malformations that were viable, indicates that most of the induced body anomalies are mutational in origin. This evidence from insects may be important for the interpretation of radiation effects in man, since insect embryos are not subject to prenatal accidents such as failures to implant and abortions, and thus can develop at least to the larval or the pupal stages even when the individual is abnormal. The rise in the frequencies with advancing age is known to be due to an increase in the number of radiation-sensitive oöcytes in the ovarioles. (auth)

9818 RADIATION STUDIES IN LENS CULINARIS: DISTRIBUTION OF CHIASMATA BETWEEN NUCLEI AND WITHIN NUCLEI IN IRRADIATED AND NON-IRRADIATED POPULATIONS. Shinha, S. S. N. (Ranchi Univ., India); Godward, M. B. E. Cytologia (Tokyo); 34: No. 1, 45-51(Mar 1969).

The effect of the same dose of γ rays was studied on the seeds of two varieties of Lens culinaris in relation to chiasma frequency. It appeared that variety macrosperma was a derived type and microsperma, the true wild one. In variety macrosperma, the chiasma frequency was slightly lower than in variety microsperma. The increase in variance ratio (mainly due to increase in the value of mean square between nuclei) in the flower buds of the plants raised from irradiated seeds was probably the result of more than one karyotype taking part in the formation of the anthers of the flowers. More karyotypes appeared to have taken part in the formation of the bud chimera at low doses than at high doses. Each plant grown from irradiated seeds had a different chimeric nature. In M_2 generation plants, there appeared to be a reversion towards normality. The variety macrosperma was affected slightly more at the same dose than the variety microsperma. (auth) (NSA of Japan)

9819 MULTIPLE RECOMBINATION MECHANISMS IN BACTERIOPHAGE P2. Lindahl, Gunnar (Karolinska Institutet, Stockholm). Virology; 39: 861-6(Dec 1969).

The vegetative genetic map of P2 bacteriophage includes a long

region without any known markers. It was shown that recombination in this region is dependent on the mechanism that is used also for integration of the prophage at lysogenization. An integration-deficient (int) mutant of P2 was isolated and located on the P2 map. Recombination over the long blank region decreases about 100-fold when both parents are int, but recombination in other parts of the P2 map is not affected. It is concluded that there are at least two mechanisms of vegetative recombination in P2, one of which depends on the int function. Recombination was not affected by the use of a recombination-deficient host for crosses. It seems therefore that P2 recombination is not dependent on the major recombination system of the host. (auth)

9820 GENETIC MAP OF BACTERIOPHAGE P2. Lindahl, Gunnar (Karolinska Institutet, Stockholm). Virology; 39: 839-60(Dec 1969).

A genetic map of bacteriophage P2 was constructed, using 37 ts mutants and several other mutants. Complementation experiments showed that the ts mutants belong to 13 different cistrons. Recombination frequencies in P2 crosses are very low but can be strongly increased by irradiating the phage with small doses of ultraviolet light; a uv dose corresponding to one lethal hit may increase the recombination frequency as much as hundredfold. The P2 map is linear and the recombination frequency between the ends is about 0.15%. A long blank region, devoid of any mutations, covers about 80% of the map. Three P2 genes are known to be active in the prophage state map in widely different places. There is a very strong negative interference in P2 crosses. This indicates that the rare event in P2 recombination is the formation of a mating pair, but once this has been formed recombination proceeds efficiently. (auth)

9821 PATTERN OF GENOPHORE REPLICATION IN Hfr AND F^- CELLS OF ESCHERICHIA COLI K-12. Mycielski, Roman; Gizycka, Zofia; Karska, Barbara; Kunichi-Goldfinger, Wladyslaw J. H. (Warsaw Univ.). Acta Microbiol. Pol., Ser. A, 1: 93-100(1969).

Rates of spontaneous and uv-induced mutations were tested during synchronized growth of one Hfr strain and four F^- strains of E. coli. Results of a typical experiment on uv-induced Str^r and thr^+ mutation frequencies in a second cell cycle of E. coli F^- W-677 synchronized with cold-shock are shown. In this strain frequencies of both mutations were doubled during short time intervals, between 120 and 135 min for Str^r and between 150 and 160 min of incubation for thr^+ mutation. Typical results of experiments on distribution of uv-induced $thy^- \rightarrow thy^+$ and $leu^- \rightarrow leu^+$ mutations in the second cell cycle of E. coli W-1611 synchronized with cold-shock, and in the first cell cycle of the same strain synchronized with selection (sucrose gradient procedure), are also presented. In cultures synchronized by both methods the doubling time of both mutation frequencies was the same, relative to the cell cycle time. The yield of spontaneously liberated lambda bacteriophages in a synchronized culture of a lysogenic F^- strain of E. coli C-600 was also examined. Results of a typical experiment showed that the number of plaque-forming units in the second cell cycle of a culture synchronized with cold-shock increases rapidly at 105 to 120 min of incubation. It is suggested that in F^- strains the replication of genophore is sequential, and is initiated in 1 point. In Hfr cells growing at lower rate (generation time 70 min) the replication rate decreases proportionally to decrease of cell growth rate. (BBB)

9822 XY FEMALES CAUSED BY X-IRRADIATION. Anders, A.; Anders, F.; Rase, S. (Justus-Liebig Univ., Giessen, Ger.). Experientia; 25: 871(15 Aug 1969).

Following x-irradiation of pregnant female fish, Platypoecilus maculatus, they gave birth to varying numbers of females with the male chromosome constitution XY. All of the XY females were normal individuals, and when they were mated with non-irradiated XY males, XX females and XY and YY males in the expected ratio of 1:2:1 were produced. Results are tabulated. (H.L.W.)

9823 CYTOLOGICAL STUDY OF A Y CHROMOSOME-AUTOSOME TRANSLOCATION IN MICE. Leonard, A.; Deknudt, Gh. (CEN, Mol, Belgium). Experientia; 25: 876-7(15 Aug 1969). (In French).

A male mouse with one translocation involving the Y chromosome was observed in the F1 offspring of a male mouse given 300 R of x radiation. Six types of spermatocytes were recorded. Observations appeared to confirm that the acrocentric X of the mouse associates end-to-end with the Y at its centromeric end. (auth)

Health Physics and Safety

Refer also to abstracts 9751, 9796, 10004, and 10145.

Radioactive Contamination and Decontamination

Refer also to abstracts 9252, 9625, 9798–9800, and 9838.

9824 (CONF-690303–, pp 145-55) UNITED KINGDOM STUDIES ON RADIOACTIVE MATERIALS RELEASED IN THE MARINE ENVIRONMENT. Dunster, H. J. (Atomic Energy Research Establishment, Harwell (England)).

The United Kingdom has always been interested in the discharge of radioactive wastes to the sea. The current policy for the disposal of radioactive wastes is discussed. As an example of this policy in practice, an account is given of the discharges of liquid waste from the fuel-reprocessing plant at Windscale to the Irish Sea. The development of discharge criteria is discussed, together with the current basis of control and the results of the monitoring program. The principal discharges from other sites of the United Kingdom Atomic Energy Authority are mentioned briefly. The stringent control exercised by the Authority and by the relevant government departments achieves a high standard of safety so that there is no damage to the marine environment and no limitation on man's use of that environment. In short, the discharges to sea are effected without creating contamination. (auth)

Dosimetry and Monitoring

Refer also to abstracts 9422–9426, 9595, 9635, 9695, 9742, 9747, 9770, 9838, 9907, and 9963.

9825 (AD-693160) BETA RADIATION DOSIMETRY FOR FALLOUT EXPOSURE ESTIMATES: COMPARISON OF THEORY AND EXPERIMENT. Final Report. Mackin, James L.; Brown, Stephen L.; Lane, William B. (Stanford Research Inst., Menlo Park, Calif.). Jun 1969. Contract N00228-68-C-3049. 73p. (USNRDL-TRC-69-26). CFSTI.

The dosimetry of exposure to fallout β radiation was investigated through comparisons of theoretical treatments with results from experimental measurements using lithium fluoride detectors. Agreement ranged from near perfect in simple geometries to factor-of-two discrepancies in the more complicated cases. Interpretations of the differences are discussed in terms of backscattering and other effects. Data on surface roughness attenuation are presented and analyzed. (auth)

9826 (AERE-M-2174) DETERMINATION OF ACTIVITY ON SURFACE CONTAMINATION SMEARS. Stephenson, J.; Morton, D. S. (Atomic Energy Research Establishment, Harwell (England)). Nov 1969. 12p. Dep. CFSTI (U. S. Sales Only). UK 1s. 9d.

The activity (in μCi's) on smears taken from beta/gamma contaminated surfaces can be estimated from measurements made with standard contamination or radiation monitoring instruments by reference to the presented curves. It is also possible to obtain an estimate of the beta energy of the contaminant if the results of measurements obtained with the appropriate instruments are used in conjunction with the curves. (auth) (UK)

9827 (CONF-690303–, pp 75-94) ESTIMATION OF THE MAXIMUM DOSE TO MAN FROM THE CONTAMINATION OF AN AQUATIC ECOSYSTEM WITH RADIONUCLIDES. Tamplin, Arthur R. (California Univ., Livermore. Lawrence Radiation Lab.).

A method is described for estimating the maximum internal dose that could result from the radionuclides released to an aquatic environment. With this analysis, the nuclides that could contribute most to the internal dose can be identified and the contribution of each nuclide to the total dose can be determined. The calculations required to estimate the maximum dose to an infant's bone after the construction of a sea-level canal are presented to illustrate the overall method. The results serve the basic aims of preshot radiation safety analysis and of guidance for postshot documentation. The usefulness of the analysis in providing guidance for device design is further pointed out. (auth)

9828 (PB-186358) NEW TECHNIQUES OF SURVEILLANCE AND MEASUREMENT: ENVIRONMENTAL RADON AND DAUGHTERS IN IN-VIVO ^{210}Pb. Final Progress Report, August 24, 1967–August 31, 1968. Eisenbud, Merril; Laurer, Gerard R.; Wrenn, McDonald E. (New York Univ., N. Y. Inst. of Environmental Medicine). 31 Aug 1968. Contract PH-86-66-149. 141p. CFSTI.

The purpose of this project is to better understand the kinetic behavior of the radon series in the environment and the human body, and to develop new techniques of surveillance and measurement. The principal interest is in the presence and behavior of radon and radon daughter products in a uranium mine environment. Radon and daughter products, either as free atoms or ions or attached to dust particles, are inhaled and subsequently de-

posited in the lungs of the uranium miners. The radioactive substances that remain in their lungs continue to decay, irradiating the tissues of the respiratory system. It has been reported that underground uranium miners in the U. S. have an incidence of lung cancer higher than the general population. One of the tasks undertaken in this study has been an attempt to estimate the cumulative radon daughter exposure of uranium miners. The method described in this report involves the in vivo detection of ^{210}Pb in the skeletons of miners using thin-crystal γ spectroscopy. A technique was investigated for reduction of radon daughter concentrations in uranium mine atmospheres by forced diffusion to the walls via rapid mixing without makeup air. A radon detector that measures integrated radon exposure has been designed, built and tested. This instrument is suitable as a personnel or area monitor. The results of the areas of investigation discussed above are presented in detail in the report. (CFSTI)

9829 IRRADIATION RELATED TO ANGIOGRAPHIC EXAMINATION IN ADULTS. Weill, F.; Bonneville, F.; Ricatte, P.; Prevotat, N.; Japy, Cl.; Bugnon, Cl. J. Radiol., Electrol., Med. Nucl., 50: 533-6(June-July 1969). (In French).

Radiation doses in radiologic examinations in which important technical changes have occurred recently were reevaluated. Four angiographic installations incorporating technical changes of recent years were studied. The installations used were as follows: Odelca continental mirror camera, monophasic A. O. T., triphasic A. O. T., and a locally constructed seriograph. For each of the four installations, measurements of the film were made for televised radioscopy and for radiography. A phantom was used for construction of absorption curves of gamma radiation. Radiation doses from each angiographic installation are presented for examination of various abdominal and thoracic organs. In all cases radiation doses in vascular radiology were extremely elevated. Methods for reducing the dose are discussed. (H.L.W.)

9830 PERSONNEL DOSIMETRY OF EXTERNAL RADIATIONS. Bekes, Marton. Fiz. Szemle; 19: 211-13(1969). (In Hungarian).

Persons who are professionally engaged in work with ionizing radiation must be systematically subjected to dosimetric measurements; there are special films with sensitivity covering the range from 10^{-2} to 10^{-3} R. The results may be evaluated and recorded automatically. The films present the disadvantage of energy dependence, direction dependence, sensitivity to elevated temperatures, humidity, and gases. The pocket ionization chamber or pen dosimeter is well suited for measuring γ radiation, as the metal housing absorbs the β rays. More recently, luminescence-type dosimeters have been introduced in practice. For the determination of the personnel dose of fast neutrons, track counting methods are used. Solid-state detectors, in which the neutron-radiation products, such as α-particles, generate tracks, present the advantage that they are insensitive to γ radiation; however, they must be developed by etching. Correction factors must be used to take into account the varying damaging effects of radiation on the organism. (TTT)

9831 RADIATION DOSAGE IN THE DENTAL OFFICE ROOM. Sonnabend, E.; Wenzel, U. (Georg-August Univ., Goettingen, Ger.). Deut. Zahnaertztl. Z.; 24: 565-77(Jun 1969). (In German).

New regulations in Germany concerning radiation protection during dental radiography are discussed. In order to obtain a survey of the size of areas used for dental practice, dosage measurements were made in the laboratory and in thirty dental offices. The result showed that the entire radiological room (usually for dental office room) would have to be supervised. In contrast to this it appears that delineation and marking of a control area is unnecessary since the x-ray technicians who work according to the rules will always be outside a zone of at least one M behind the tube. The measured results also show that, provided the radiation protection regulations are adhered to, one can no longer object against positioning the radiological equipment in the unit or on the patient's chair. (auth)

9832 LYMPHATIC AND VISCERAL IRRADIATION FROM ENDOLYMPHATIC INFUSION IN THE RABBIT. Lord, Reginald; Gaunt, Judith I.; Kinmonth, J. B. (St. Thomas's Hospital, London). Amer. J. Roentgenol., Radium Ther. Nucl. Med., 106: 700-7(Aug. 1969).

Dosimetric studies were carried out in 46 rabbits after endolymphatic infusions of ^{32}P and ^{131}I in Ultrafluid Lipiodol. There were no important differences between the behavior of the isotopes. Greatest uptakes were recorded by the popliteal and iliac lymph nodes (mean of approximately 10% of the administered dose per gram of lymph node). The energies equivalent to the mean lymph node uptakes (73,000 and 55,000 rads) greatly exceeded the radiation doses possible with other forms of radiotherapy. In some lymph nodes the absorbed irradiation reached hundreds of thousands of rads. The irradiation received by most other viscera and the carcass generally was trivial by comparison. The lungs recorded uptakes at levels that were high because of the large volumes injected. The major route of the ^{32}P compounds was by the kidneys. Daily excretion rates varied considerably but were usually about 1 to 2% of the administered dose per day. Calculations based on either renal uptakes or renal excretion rates indicated that the quantities of irradiation received ought not to be nephrotoxic. The concentration of ^{32}P in the blood declined from a peak of 1 to 2% of the administered dose per 100 ml in the first week to unrecordable levels over the succeeding three to five weeks. Tri-n-octyl phosphate was found to be unstable in plasma and in urine. Despite this instability, no significant localization of ^{32}P in the skeleton was apparent. (auth)

9833 NEUTRON EXPOSURE TO LUNAR ASTRONAUTS. Kastner, J.; Oltman, B. G.; Feige, Y.; Gold, R. (Argonne National Lab., Ill.). Health Phys., 17: 732-3(Nov. 1969).

The flux and energy distribution of neutrons generated by cosmic rays in lunar material can be inferred from knowledge of neutrons generated by cosmic rays in the earth's atmosphere and at the air-ground interface. (UK)

Radiation Protection

9834 LA RADIOPROTECTION. (Radioprotection). Bonet-Maury, Paul. Que Sais-Je. Le Point des Connaissances Actuelles, No. 1347. Paris, Presses Universitaires de France, 1969. 136p.

Ionizing radiations are discussed in the first chapter of the book with regard to nature, origin, transfer of radiation energy to the medium, absorption of various kinds of radiation, quantities and units, and detection and measurement. The second chapter is concerned with biological effects of radiation. The origin of radiolesions is considered, and somatic and genetic effects of external radiation, as well as factors modifying external effects are discussed. Effects of accidental ingestion of radioisotopes are discussed. The third chapter is concerned with legislation and medico-social problems. Standards of tolerance are discussed with regard to evaluation of risks and equivalents of maximum permissible dose. Protection of personnel and repair of damage following accidents are also considered. The fourth chapter is concerned with technology of radiation protection. Methods of reducing the dose to personnel, equipment, instruments, and internal contamination are considered. The fifth chapter is concerned with organization and functioning of a radiation protection service. (H.L.W.)

Safety Procedures

9835 SURVEY OF TECHNIQUES EMPLOYED TO DEFINE AEROSOL "RESPIRABLE DUST" CONCENTRATION AND PARTICLE SIZE CHARACTERISTICS. Ettinger, Harry J. (Los Alamos Scientific Lab., N. Mex.). Aug 1969. Contract W-7405-eng-36. 12p. Dep. CFSTI.

A survey was carried out to determine what air sampling procedures are currently used to evaluate inhalation hazards at U. S. Atomic Energy Commission contractor facilities. The survey showed that samplers for determining respirable dust concentration or aerosol particle size analysis are used infrequently. Many of the methods used will not provide a reliable estimate of particle aerodynamic diameter. The adoption of standard sampling methods is indicated. To facilitate standardization, a manual of recommended sampling procedure and short course training should be developed within the AEC. (auth)

9836 (STI/PUB-227) PLANNING FOR THE HANDLING OF RADIATION ACCIDENTS. A Manual Prepared by a Panel of Experts on Behalf of ILO, FAO, WHO and the IAEA. Safety Series No. 32. (International Atomic Energy Agency, Vienna (Austria)). 1969. 100p. Dep. IAEA $3.00.

This manual is intended as a practical guide for the use of public authorities and others who are responsible for preparing emergency plans for the handling of radiation accidents, with the aim of minimizing the exposure of personnel and the public, and of reducing damage to property. Topics discussed include radiation accidents and their control; organization for handling radiation accidents; the responsibility of public authorities and personnel for the control of radiation sources; guides for decisions on protective action; and essential components of radiation protection plans. A number of specimen emergency plans are appended. (C.H.)

9837 THE STATE OF HEMOPOIESIS DURING THE ACTION OF LOW DOSES OF IONIZING RADIATION. Kurdybailo, F. V.; Murashov, B. F. Probl. Gematol. Pereliv. Krovi; 14: No. 10, 33-6(Oct 1969). (In Russian).

The authors present the results of studying the peripheral blood and the state of hemopoiesis in persons who had a prolonged contact with constantly acting fluorescent mixtures (CAFC) serving as a source of mixed radiation. Leukocyte and thrombocyte count is seen to fall in the blood of some of the persons after 4 to 5 years of work with CAFC. Qualitative changes of the blood elements occurred in 10 persons. A moderate stimulation of the erythroid series, disturbance of maturation at the stage of polychromatophilic normoblast and a delay of maturation at the stage of promyelocyte was revealed in the bone marrow. The number of reticular and plasmatic cells rose in some of the patients. (auth)

Civil Defense

9838 HEALTH PHYSICS. VOLUME 2. PART 1. Duhamel, A. M. F. (ed.). Progress in Nuclear Energy. Series XII. Oxford; Pergamon Press (1969). 761p. 200s.

The following topics are reviewed: Scientific research and radiological protection by W. G. Marley. Present status of recommendations of the I.C.R.P., National Council on Radiation Protection, and Federal Radiation Council by K. Z. Morgan. Cellular effects of ionizing radiation by C. A. Tobias. The indirect radiobiological effect by O. Costachel. Approach to a new research method on the action of radiations at molecular levels by P. Dalattre. Biological effects on atomic bomb survivors in Hiroshima and Nagasaki by K. Tsukamoto. Importance of radiation burden of a population with special reference to the genetically significant dose from application of radiation medicine by W. Seelentag. Radionuclide contamination and removal by W. J. Blair and V. H. Smith. Neurophysiological effects of ionizing radiation by M. P. Avargues. Radiation quantities and units by L. S. Taylor. Estimation of dose within the body on basis of personnel monitoring data by W. S. Snyder. Recent researches into biological tissue equivalent detectors by D. Blanc. Dosimetry of very high energy radiation by J. Baarli. Principal characteristics of radioactive contaminants which may appear in the atmosphere by K. Stewart. Problems of safety and radiation protection around high energy accelerators by M. Ladu. Radioprotection and reactor safety by F. Kertesz and R. Affel. Systematics of reactor siting by V. V. Shirvackar and A. K. Ganguly. Problems of highly active waste management by W. H. Hardwick and J. R. Goner. Consequences of radioactive disposals into the ground by C. A. Mavson. Radiological protection and underground nuclear explosions by C. Gaille-dreau. Radioactive contamination of the upper atmosphere by J. Z. Holland, J. E. Niller and R. E. Newell. Global contamination due to radioactive fallout by Y. Nishiwaki et al. Space Radiation dosimetry by R. Madey. Radiation hazards and radiation safety standards in manned space operations by H. J. Schaefer, and Migration of radionuclides in porous media by L. H. Baetsle. (UK)

9839 FOOD AND NUTRITION PROCEDURES IN TIMES OF DISASTER. Masefield, G. B. FAO Nutritional Studies, No. 21. Rome, Food and Agriculture Organization of the United Nations, 1967. 103p. $2.00; 16s.

A handbook that emphasizes the practical aspects of food management in times of disaster is presented. General topics included precautions against food shortage, general administration of relief, food procedures in different types of emergencies (medium and long-term), special aspects of emergency feeding, and medical problems during famine. An appendix section details nutritional aspects of food. (C.O.)

Legal Aspects

Refer also to abstracts 9797, 9831, 9836, 9838, and 9970.

9840 (CONF-690303–, pp 63-72) APPLICATION OF BASIC RADIATION PROTECTION CRITERIA. Parker, Herbert M. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Evaluation of each Plowshare program should be made individually, providing the necessary studies and population considerations, so that the correct dose-limit guidance for determining acceptable conditions can be applied. The AEC and the Public Health Service need to give careful attention to collecting and analyzing environmental exposures and dose data so that knowledge may be gained from experiences and safe conditions assured. The good record of the nuclear energy program must be maintained by not making unsafe errors in estimating the consequences of any Plowshare programs. Plowshare can be performed safely. To do so requires good judgment, sound application of existing radiation protection guidance, and sufficient funding to meet the needs of practical safety safety programs. A safe approach using the public exposure or the general population dose control limits, as the situation may demand, is necessary to help assure the rapid development of Plowshare programs. A high priority should be assigned to developing methods to apply the existing radiation protection guidance so that Plowshare programs may proceed safely. There seems to be no doubt but that the peaceful applications of nuclear energy in Plowshare programs will develop as rapidly as funding and commercial opportunities present themselves. (auth)

9841 (STI/PUB–215) NUCLEAR LAW FOR A DEVELOPING WORLD. Legal Series No. 5. Lectures Given at a Training Course, Vienna, April 16–26, 1968. (International Atomic Energy Agency, Vienna (Austria)). Aug. 1969. 335p. IAEA $9.00.

Thirty-three separate abstracts were prepared for inclusion in NSA. These lectures were divided into seven sections: international organizations; basic legislation on atomic energy; third party liability and insurance; reactor licensing and supply of nuclear materials; safety regulations; technical assistance, food irradiation, nuclear power, training in nuclear law; and safeguards. A list of lecturers and participants is included. (C.O.)

For abstracts of individual papers see: 9842–9872, 11160, and 11161.

9842 INTERNATIONAL ATOMIC ENERGY AGENCY. Fischer, D. A. V. (International Atomic Energy Agency, Vienna). pp 3-14 of Nuclear Law for a Developing World. Vienna, International Atomic Energy Agency, 1969.
See STI/PUB–215.

An historical summary of the origin of IAEA is presented. The structure of the agency as it exists today is then described; the promotional work (exchange of information, technical assistance, and support, and coordination of research) and the regulatory work in the agency is outlined. The administrative regime is compared to that of the United Nations. Prospects for the future, based on current negotiations, are discussed. (C.O.)

9843 TEN YEARS OF THE INTERNATIONAL ATOM. Hall, J. A. (International Atomic Energy Agency, Vienna). pp 15-19 of Nuclear Law for a Developing World. Vienna, International Atomic Energy Agency, 1969.
See STI/PUB–215.

The early history of the IAEA is discussed topically; changes and trends of the past ten years are pointed out. The status of atomic power, INIS, safeguards, technical assistance, and the secretariat (board of governors) were the areas with the greatest degree of change. The political importance of having IAEA headquarters in Vienna is very briefly discussed. (C.O.)

9844 EUROPEAN NUCLEAR ENERGY AGENCY. Stein, R. M. (European Nuclear Energy Agency, Paris). pp 21-32 of Nuclear Law for a Developing World. Vienna, International Atomic Energy Agency, 1969.
See STI/PUB–215.

The structure and activities of ENEA are rich in interest for lawyers concerned with nuclear energy, and the contribution of ENEA to the development of nuclear law is outstanding proof of the dynamic and creative role that international organizations can play in this field. (auth)

9845 THE INTER-AMERICAN NUCLEAR ENERGY COMMISSION. ORGANIZATION, FUNCTIONS, AND PROSPECTS. Zaldivar, E. (National Nuclear Energy Commission, Buenos Aires). pp 33-8 of Nuclear Law for a Developing World. Vienna, International Atomic Energy Agency, 1969.
See STI/PUB–215.

A brief review of the organization, activities and prospects of the Inter-American Nuclear Energy Commission is presented. It will be seen that the Commission is a specialized body with a sound legal basis and that, although founded several years ago, it is still in an initial stage of development. The task that it should, and expects to, fulfill is a very extensive one, but its future depends on the effective support that it receives from its member States. (auth)

9846 THE EUROPEAN ATOMIC ENERGY COMMUNITY (EURATOM). Glaesner, H. J. (EURATOM, Brussels). pp 39-45 of Nuclear Law for a Developing World. Vienna, International Atomic Energy Agency, 1969.
See STI/PUB–215.

A study of the treaty establishing EURATOM is considered, not solely from the nuclear point of view, but also from within the context of the European community. The role of the European Atomic Energy Community (within the framework of the Treaty) is described and discussed; emphasis is placed on measures connected primarily with the exercise of public powers, measures in the field of research, and measures taken with a view to the development of nuclear industries. (C.O.)

9847 COUNCIL FOR MUTUAL ECONOMIC ASSISTANCE. Belov, A. (International Atomic Energy Agency, Vienna). pp 47-52 of Nuclear Law for a Developing World. Vienna, International Atomic Energy Agency, 1969.
See STI/PUB-215.

A general picture of the Council for Mutual Economic Assistance's (CMEA) aims, membership, and structure is presented and then followed by a broader survey of its past and present activities related to the peaceful uses of atomic energy. One body of the CMEA, the Standing Commission on Peaceful Uses of Atomic Energy, is particularly discussed; the Commission's attachment of great importance to standardization questions is included. (C.O.)

9848 DEVELOPMENT OF NUCLEAR LAW. Boulanger, W. (International Atomic Energy Agency, Vienna). pp 55-63 of Nuclear Law for a Developing World. Vienna, International Atomic Energy Agency, 1969.
See STI/PUB-215.

Definition of nuclear law and the areas of law included are presented. The evolution of nuclear law within the past 23 years is outlined and discussed. The contributions of the IAEA to this evolution are considered. (C.O.)

9849 BASIC FEATURES OF THE U.S. ATOMIC ENERGY COMMISSION. Spingarn, E. E. (Atomic Energy Commission, Washington, D. C.). pp 65-76 of Nuclear Law for a Developing World. Vienna, International Atomic Energy Agency, 1969.
See STI/PUB-215.

A general picture of the essential structure, organization, and important programs of the USAEC is presented. Means used in pursuit of the goals set out in the policy statement and for the development, use, and control of atomic energy is directed so as to promote world peace, improve the general welfare, increase the standard of living, and strengthen free competition in private enterprise are discussed. (C.O.)

9850 THE UNITED KINGDOM NUCLEAR LEGISLATION. Trevor, J. P. H. (Her Majesty's Solicitor's Dept., London). pp 77-81 of Nuclear Law for a Developing World. Vienna, International Atomic Energy Agency, 1969.
See STI/PUB-215.

The application in United Kingdom law of the rules found in the ratification of the Paris Convention and the Brussels Supplementary Convention and proposals to ratify the Vienna Convention are discussed in relation to principles. The statute, the Nuclear Installations Act, 1965, is also discussed in relation to the different kinds of United Kingdom operators of nuclear installations. (C.O.)

9851 BASIC FEATURES OF THE COMMISSARIAT A L'ENERGIE ATOMIQUE. Vergne, J. (CEA, Paris). pp 83-93 of Nuclear Law for a Developing World. Vienna, International Atomic Energy Agency, 1969.
See STI/PUB-215.

Although the basic features of the modest establishment created in 1945 have been worn by time and molded by experience, although its freedom of action has been reduced to some extent, and although various ministries and other bodies have also embarked on the atomic adventure, the Commissariat à l'Énergie Atomique remains the largest atomic energy organization in France by virtue of those very features that have not been basically modified. Through the special interest shown by the President of the Republic, the encouragement of the responsible minister, the outstanding qualities of the Administrator General and the High Commissioner, and the skill and devotion of all its staff, the Commissariat has fulfilled, and is continuing to fulfill, the task originally assigned to it. In spite of this support and these advantages, if the Commissariat had not been soundly based at the very outset, if it had not been answerable directly to the Premier or his representative, and particularly if it had not been given a large measure of independence, it would not have succeeded in fulfilling its mission and France would not occupy the place she holds in the new world of nuclear energy. (auth)

9852 WORK OF THE FOREIGN OFFICE LAWYER IN THE FIELD OF PEACEFUL USES OF ATOMIC ENERGY. Maurer, E. (Dept. of State, Washington, D. C.). pp 95-105 of Nuclear Law for a Developing World. Vienna, International Atomic Energy Agency, 1969.
See STI/PUB-215.

The relevance of the work of the Foreign Office lawyer in the field of atomic energy to the interests of this training course are indicated; some conception of the different legal offices in the United States Government working in atomic energy is attempted; internal procedures relating to the making of international agreements in this field are described; the various categories of agreements in which the United States has been involved are discussed, and finally the special legal services rendered by the Foreign Office lawyer are illustrated. (C.O.)

9853 PRINCIPLES OF CIVIL LIABILITY FOR NUCLEAR DAMAGE. Trevor, J. P. H. (Her Majesty's Treasury Solicitor's Dept., London). pp 109-15 of Nuclear Law for a Developing World. Vienna, International Atomic Energy Agency, 1969.
See STI/PUB-215.

A short résumé of the more important principles of third party nuclear liability is presented. It does not purport to be comprehensive and the Conventions and examples of national law based on the Conventions should be examined. Only then will it be realized how complicated the necessary detailed provisions need to be. (auth)

9854 NUCLEAR LIABILITY: STUDY OF A NATIONAL LEGISLATION IN THE LIGHT OF INTERNATIONAL CONVENTIONS. de los Santos Lasurtegui, A. (Junta de Energia Nuclear, Madrid). pp 117-42 of Nuclear Law for a Developing World. Vienna, International Atomic Energy Agency, 1969.
See STI/PUB-215.

The scope of application of nuclear legislation must be limited and clearly defined by special legislation. Civil liability for damage to third parties arising from a nuclear incident is concentrated in the operator of the nuclear installation involved. The operator's liability to provide compensation for nuclear damage must be limited, without prejudice to any contribution the State may make when the yield of the insurance or other financial security is insufficient to cover all damage. The period for submission of claims for compensation must be at least ten years, but the State may, by establishing a special fund for the purpose, provide compensation for delayed or deferred damage even when the claims are presented after the normal extinction period. No nuclear installation may be licensed and put into operation until the operator has obtained insurance or other financial security to cover his liability. It is desirable that a single court should have jurisdiction to hear claims for compensation for nuclear damage, and that a special expeditious procedure should be used, leaving the court wide discretion in the handling of evidence (which should include the advice of the competent nuclear energy authority). It would also be highly advisable to have the victims represented, whenever possible, by the public prosecutor. The State must intervene not only in its legislative capacity but also, whenever necessary, to make up the balance of compensation owed to victims. These principles are embodied in the International Conventions and also in the Spanish Nuclear Energy Act, one of the aims of which, as is clearly stated in the preamble, was to fulfil the provisions of the international agreements. (auth)

9855 BRUSSELS SUPPLEMENTARY CONVENTION AND ITS JOINT INTERGOVERNMENTAL SECURITY FUND. Lagorce, M. (CEA, Paris). pp 143-8 of Nuclear Law for a Developing World. Vienna, International Atomic Energy Agency, 1969.
See STI/PUB-215.

The provisions relating to the liability of land-based nuclear installations at the three Conventions prior to the Brussels Supplementary Convention (BSC) are discussed. The provisions relating to compensation by the state for damage not compensated under the Paris Convention are succinctly outlined. The field of application of the BSC and the original machinery of the convention are also discussed in relation to its three aspects: compensation of persons suffering damage, compensation procedure, and formula for contributions by the contracting parties. (C.O.)

9856 NUCLEAR INSTALLATIONS: INSURANCE PROBLEMS. Miles, A. C. (British Insurance (Atomic Energy) Committee, London). pp 149-58 of Nuclear Law for a Developing World. Vienna, International Atomic Energy Agency, 1969.
See STI/PUB-215.

Those responsible for nuclear insurance, who have worked together harmoniously in the common task of ensuring that the insurance markets continue to fulfill their best tradition by keeping abreast of new developments in technology, believe that they have reason for satisfaction. Their efforts have made it possible for administrative arrangements to be made in good time to anticipate possible problems, so that as the major atomic projects move from the drawing board to the constructional and operational stages the nuclear industry thus finds facilities for insurance awaiting them, despite the enormous values involved at a single site. (auth)

9857 INSURANCE AGAINST NUCLEAR RISKS IN EUROPE. Lacroix, F. (European Insurance Committee, Brussels). pp 159-66 of Nuclear Law for a Developing World. Vienna, International Atomic Energy Agency, 1969.
See STI/PUB-215.

Large-scale risks, i.e., those pertaining to reactors and to

ancillary industries such, for instance, as fuel element fabrication and irradiated fuel reprocessing are discussed. However, besides the applications of the atomic nucleus to provide power, insurers have also been concerned in the extremely varied field of application of radioisotopes and radiation in industry, agriculture, medicine and research. These risks are not of an exceptional nature and are covered by insurance companies as a routine operation. In most European markets these operations are conducted outside the atomic pools, although the latter often appear in this field as technical advisers. The problems posed by insurance against nuclear risk are still numerous. Indication is given of the considerable effort made by nuclear insurers in the course of this last decade, an effort that is enabling insurance to fulfill its traditional function of providing security and also to facilitate the development of the peaceful uses of nuclear energy. (auth)

9858 NUCLEAR ENERGY LIABILITY INSURANCE IN THE UNITED STATES OF AMERICA. Fisher, R. J. (Hartford Insurance Group, Conn.). pp 167-74 of Nuclear Law for a Developing World. Vienna, International Atomic Energy Agency, 1969.

See STI/PUB-215.

The federal government aspects of nuclear liability insurance in the United States is discussed; the interplay between the indemnity program and this insurance is included. The role of the liability insurance industry in assisting nuclear industry in this respect is also pointed out. Policy coverage, amounts of financial protection, rating, claims, extension of the Price–Anderson Act, and waiver legislation are topics included. (C.O.)

9859 INTERNATIONAL CONVENTIONS AND AGREEMENTS ON NUCLEAR SHIPS. Boulanger, W. (International Atomic Energy Agency, Vienna). pp 175-80 of Nuclear Law for a Developing World. Vienna, International Atomic Energy Agency, 1969.

See STI/PUB-215.

Basic information on international legal regulations that might be useful when playing host to a foreign nuclear ship is presented. Agreements concerning the Savannah ship are tabulated. (C.O.)

9860 THE SUPPLY OF NUCLEAR MATERIALS THROUGH THE IAEA. Pedersen, O. (International Atomic Energy Agency, Vienna). pp 197-205 of Nuclear Law for a Developing World. Vienna, International Atomic Energy Agency, 1969.

See STI/PUB-215.

The role of the IAEA in the supply of nuclear material is discussed in relation to the IAEA's function, aspects of the uranium market, availability of material, and general supply agreements. Consideration is also given to procedures for the supply of nuclear materials in relation to requests, choice of supplier, agreements, and terms and conditions. Use of the IAEA supply service by member countries is briefly discussed. (C.O.)

9861 TECHNICAL BASIS OF REGULATORY MEASURES FOR RADIATION PROTECTION. Agu, B. N. C. (International Atomic Energy Agency, Vienna). pp 209-23 of Nuclear Law for a Developing World. Vienna, International Atomic Energy Agency, 1969.

See STI/PUB-215.

The effort of the international organizations competent in radiation protection is not limited to providing recommendations. Increasingly large numbers of states, especially from the developing countries, are asking the IAEA and the specialized agencies of the United Nations for expert assistance in drawing up their national legislations and regulations on radiation protection. Usually experts are sent to these countries to study local conditions and draw up a draft which could later be made law. Sometimes countries will draw up their draft legislations and only seek the Agency's view on the suitability of such draft. At the moment there is a joint technical advisory service on radiation protection and waste management involving the IAEA, FAO and ILO, and in a recent meeting, both the WHO and IAEA considered it desirable to decide as early as possible to use the same basic documents in advising Member States on the establishment of national regulations and legislations on radiation protection. It is hoped that a basic document on radiation protection legislation will materialize, which together with the Agency's Basic Safety Standards will filfill a long felt need, particularly in the developing countries. (auth)

9862 THE IAEA REGULATIONS FOR THE SAFE TRANSPORT OF RADIOACTIVE MATERIALS. Ha Vinh Phuong (International Atomic Energy Agency, Vienna). pp 225-30 of Nuclear Law for a Developing World. Vienna, International Atomic Energy Agency, 1969.

See STI/PUB-215.

It may be said that, through active co-operation at the international level, a number of essential standards have to date been established, providing an adequate framework for the peaceful utilization of nuclear energy. Among these standards, the Agency's Transport Regulations deserve a special mention because of their remarkable impact upon national as well as international regulations. More efforts still will be required to enlarge the acceptance and application of these regulations, and to improve communication between national authorities for increased collaboration in the handling of the practical problems involved. Because of past achievements, we may however look forward with confidence to greater harmonization in this field in a not too distant future. (auth)

9863 CONTROL OF RADIOACTIVE WASTE DISPOSAL. Browder, F. N.; Parsons, P. J. (International Atomic Energy Agency, Vienna). pp 231-9 of Nuclear Law for a Developing World. Vienna, International Atomic Energy Agency, 1969.

See STI/PUB-215.

The main recommendation is that in countries where none so far exist, legal powers should be taken and an administrative organization established to control radioactive material, particularly the disposal of radioactive wastes to protect public health. The basic legislation should initiate a system of both licensing users and authorizing disposals. It should contain no figures, which are better given in licences, authorizations and exemption orders, all of which should be capable of easy review and change. The disposal of low-activity wastes to the environment is recommended, provided the legal control mentioned above is established and the administration can call upon technical advisers who are competent to undertake the safety assessments made necessary by the recommended practice of judging each case on its own merits. In setting up regulations controlling radioactive waste disposal it has generally been shown undesirable to impose inflexible and over-restrictive limits to provide a complete blanket margin of safety for every conceivable set of circumstances. To enforce ultra-low disposal limits on a nuclear facility is to impose a considerable economic burden that is unrealistic in terms of environmental safety and constricting to normal growth. Such principles may have been justifiable in the early days where there was no experience of radioactive disposals and no means accurately to predict the consequences of radioactive releases to the environment. But the experience of 20 years or so of routine disposal operations shows that, while initial caution is necessary, most environments have considerable capacity to accept radioactive wastes with safety in the same way as they can absorb conventional wastes. (auth)

9864 THE IAEA SUPPLEMENTARY AGREEMENT TO THE UNDP REVISED STANDARD AGREEMENT ON THE PROVISION OF TECHNICAL ASSISTANCE. Ha Vinh Phuong (International Atomic Energy Agency, Vienna). pp 243-7 of Nuclear Law for a Developing World. Vienna, International Atomic Energy Agency, 1969.

See STI/PUB-215.

A copy of the supplementary agreement concerning the provision of technical assistance by the IAEA to the government of almost any country in the world is presented. A list of the countries that signed the agreement is included. Under the Supplementary Agreement, the IAEA's assistance can be given to individual projects through a letter addressed to the government concerned, describing the type and duration of the assignment of an expert; no further letter exchange is required. (C.O.)

9865 PROSPECTS OF FOOD IRRADIATION. Goresline, H. E. (International Atomic Energy Agency, Vienna). pp 249-56 of Nuclear Law for a Developing World. Vienna, International Atomic Energy Agency, 1969.

See STI/PUB-215.

The uses of ionizing radiation as a food processing method is discussed in relation to development of legislation on distribution and use of irradiated food throughout the world. Problems in bringing food irradiation into use are also discussed. Results of a general survey of irradiated food products cleared for human consumption in different countries are presented in tabular form; a list of food irradiation pilot plants is also presented. Assistance by international organizations toward implementation of greater use of food irradiation is then briefly discussed. (C.O.)

9866 NUCLEAR POWER AND DEVELOPING COUNTRIES. Khan, Munir A. (International Atomic Energy Agency, Vienna). pp 257-74 of Nuclear Law for a Developing World. Vienna, International Atomic Energy Agency, 1969.

See STI/PUB-215.

Current trends in nuclear power in the world are pointed out, a review is made of the present outlook for nuclear power in developing countries, and the problems and prospects of its intro-

duction into these developing countries is briefly discussed. Included in the article is background information necessary for appreciation of the impact that nuclear power will have in developing countries and that will assist experts in atomic law and legal advisors to the Nuclear Energy Commission as to ideas of the technical and economic problems that are encountered in the introduction of nuclear power into these countries. (C.O.)

9867 TRAINING OPPORTUNITIES AND BIBLIOGRAPHY IN ATOMIC ENERGY LAW. Camcigil, M. (International Atomic Energy Agency, Vienna). pp 275-82 of Nuclear Law for a Developing World. Vienna, International Atomic Energy Agency, 1969.
See STI/PUB-215.

The need and interest ascribed to the teaching of atomic energy law at national levels is described; details given were comprehensive. Included in the description were opportunities for training and proposals for a more comprehensive atomic energy law course. A selected bibliography on atomic energy law is given; 72 references were cited and 8 periodicals were listed (both French and English language references were given). (C.O.)

9868 INTRODUCTORY STATEMENT ON SAFEGUARDS. McKnight, A. D. (International Atomic Energy Agency, Vienna). pp 285 of Nuclear Law for a Developing World. Vienna, International Atomic Energy Agency, 1969.
See STI/PUB-215.

Philosophical remarks on safeguards are presented. It is emphasized that safeguards are not necessarily something alien and imposed arbitrarily from outside a state. Included in the remarks are statements pertaining to the distinctiveness of nuclear material; it imposes health hazards, has a high market value, has black market value, and black market sales may represent a serious threat to society. (C.O.)

9869 LEGAL ASPECTS OF SAFEGUARDS. Rainer, R. (International Atomic Energy Agency, Vienna). pp 287-98 of Nuclear Law for a Developing World. Vienna, International Atomic Energy Agency, 1969.
See STI/PUB-215.

The safeguards system of the IAEA is discussed. A general survey made to analyze the structure of IAEA safeguards and to identify the components of the IAEA's safeguards system is included. In the IAEA's safeguards system survey, the bilateral, regional, and world-wide (international) safeguards are discussed; the basic elements of an international control system are explained; the objective of and items subject to safeguards are discussed; fact-finding mechanisms (safeguards procedures) are described; the binding character of the control system is outlined; sanctions in case of non-compliance are set forth; and functions or competence of the IAEA in the operation field are delineated. IAEA's safeguards documents are then discussed in relation to relevant provisions of the system. (C.O.)

9870 SOME PRACTICAL ASPECTS OF SAFEGUARDS IMPLEMENTATION. Arsenault, F. (International Atomic Energy Agency, Vienna). pp 299-305 of Nuclear Law for a Developing World. Vienna, International Atomic Energy Agency, 1969.
See STI/PUB-215.

The legal instruments that bring into action the application of IAEA safeguards and the mechanisms by which they are translated into the administrative and technical procedures required for practical implementation are described. The things that must be done before the IAEA assumes responsibility for applying safeguards, specifically the system of records and reports of the state to be submitted to the agency, are discussed and then a state-agency arrangement is discussed in detail. (C.O.)

9871 SOME TECHNICAL ASPECTS OF SAFEGUARDS. Shmelev, V. (International Atomic Energy Agency, Vienna). pp 307-14 of Nuclear Law for a Develcping World. Vienna, International Atomic Energy Agency, 1969.
See STI/PUB-215.

The technical aspects of safeguards, i.e., the prevention of possible diversion of peaceful activities with nuclear energy to nonpeaceful uses, is discussed. The nuclear fuel cycle is described and the technical requirements for safeguards that can be applied to all kinds of nuclear material when they are processed are discussed in relation to present techniques (seals, inspector observation, monitors, operation verification, and sampling). A program for safeguards research and development is described. (C.O.)

9872 THE TREATY FOR THE PROHIBITION OF NUCLEAR WEAPONS IN LATIN AMERICA (TLALTELOLCO TREATY). Rainer, R. (International Atomic Energy Agency, Vienna). pp 315-23 of Nuclear Law for a Developing World. Vienna, International Atomic Energy Agency, 1969.
See STI/PUB-215.

The genesis of the Treaty for the Prohibition of Nuclear Weapons in Latin America is presented. Obligations of the contracting parties, definition of nuclear weapons, peaceful nuclear explosions by contracting parties, and the verification and control systems of contracting parties are discussed. The obligations to nuclear weapon states toward the contracting parties the transit of nuclear weapons through the treaty zone, and clauses on entry into force of the Treaty are also discussed. The discussion is concluded with a brief synopsis of Treaty duration and relations of the Agency with other organizations. (C.O.)

Medicine

Refer also to abstracts 9404, 9600, 9601, 9696, 9751, and 9796.

9873 APPLICATION TO RESEARCH AND ITS PROBLEMS: PHARMACOLOGY. Tamemasa, Osamu (Shizuoka Coll. of Pharmacy, Japan). Genshiryoku Kogyo, 15: No. 5, 36-40(May 1969). (In Japanese).

Applications of radioisotopes and radiation to pharmacology, are reviewed especially medical science and production of medicines, sanitary chemistry, and criminal chemistry. The various fields of pharmacology are classified in relation to radiation and radioisotopes: production, study, and development of drugs and medical supplies, (including production, research, screening and study of medical materials; the studies to investigate new substances having biological activity, the studies on biosynthesis mechanism of natural substances by the tracer method, the action mechanism of antibiotics and others; analysis and test of medical supplies; the dilution analysis of radioactive elements using various kinds of chromatography or the scintillation counter; research and testing of the physiological and pharmacological actions of medical supplies; the pursuit of medicines labeled with radioactive elements and the distribution of medicines using autoradiography; preparation of medicines and sterilization of medicines and medical supplies); medical supplies having radioactivity for use for scintiscanning and testing of vital functions; synthesis and preparation of radioactive compounds: ^{3}H, ^{14}C, ^{35}S, ^{75}Se, etc. are generally applied; study of the protective substances against radioactivity including chelates; and criminal and forensic chemistry; the qualitative and quantitative microanalysis due to radioactivation by neutrons. (TSS) (NSA of Japan)

Protective Substances

Refer also to abstracts 9303, 9740, 9741, 9789, 9817, 9912, 9941, 9966, 9967, and 9971.

9874 (AD-692983) PHARMACODYNAMICS OF A RADIOPROTECTIVE DRUG: 2- (1-DECYLAMINO)ETHANETHIOSULFURIC ACID. Final Report, February-May 1968. Martinez-O'Ferrall, Jose A.; Melville, George S. Jr. (School of Aerospace Medicine, Brooks AFB, Tex.). Jun 1969. 15p. (SAM-TR-69-31). CFSTI.

One phase of the search for radioprotective agents is the study of the physiologic and pharmacologic mechanisms responsible for toxic and protective effects. In this study, the drug 2-(1-decylamino)ethanethiosulfuric acid (WR-1607) was injected, according to different dosage schedules, into control and irradiated Macaca mulatta monkeys. Changes in hemograms and blood chemistry were measured, and clinical observations were recorded. The response in control animals appeared to be that to a temporary chemical challenge with prompt recovery within one week. In the irradiated animals, the response corresponded to a subacute radiation syndrome. In this experiment, WR-1607 failed to mobilize physiologic mechanisms for protection against radiation injury. Further investigation of this drug as a radioprotectant should consider a different approach in method of administration. (auth) (TAB)

9875 PROTECTION AGAINST WHOLE BODY X-IRRADIATION BY ADRENOCHROME MONOGUANYLHYDRAZONE METHANE SULPHONATE IN MICE. Sugahara, T.; Tanaka, T. (Kyoto Univ.). Nature (London); 220: 271-2(19 Oct 1969).

Adrenochrome is an indole derivative of adrenaline but has none of the pharmacological properties of adrenaline; it has been shown to possess a small degree of radioprotective action. This also applies to the monosemicarbazone derivative and to the 3-sodium sulphonate. The guanyl derivative has become commercially available in Japan, and is more soluble; it was thought that it might afford more protection against radiation because it could

be given in larger doses, on account of its higher solubility. The results of the investigation described indicate that this compound has a definite protective effect even at very low doses, far below the toxic level, and its applicability to humans would appear to be promising. Whole body X-irradiation at 190 kVp, 25 mA was employed. The test compound, dissolved in physiological saline, was injected intraperitoneally 15 min before irradiation, and the mice were observed for 30 days. The relationship between injected dose and protective effect is shown. Survival was maximum at the low dose of 5 mg/kg. The LD_{50} was estimated as 1,834 mg/kg when given subcutaneously. No side effects were observed with doses of 50 to 200 mg. It has been reported that the compound has no toxic or radioprotective action on E. coli, suggesting that there may be some pharmacological mechanism specific for mammals. Studies to elucidate mechanisms are in progress. (UK)

9876 RADIATION PROTECTIVE PROPERTIES OF AZA-ANALOGS OF THE PRECURSORS OF NUCLEIC ACIDS. Svatkov, V. I. Gig. Sanit.; No. 11, 96-8(Nov 1968). (In Russian).

More pronounced radioprotective effects were demonstrated by azapurines (azaguanine and azaxanthine) than by azapyrimidines (azauracil, azauridine, and azacytidine). The protective effect depends on the time of introduction of the antimetabolite before x irradiation. Specific differences in the protective action of azaguanine on survival, the average continuance of life, and the leucocyte count in the blood of irradiated mice and rats were noted. The LD_{50} of azaguanine on white mongrel mice was established and the absence of its influence on arterial pressure and respiration quotient was demonstrated. Azacytidine possessed marked toxicity in mice. (tr-auth)

9877 THE EFFECTS OF ATP AND KINETIN ON THE FREQUENCY OF CHROMOSOME RECOMBINATIONS INDUCED BY X RAYS IN SEEDS OF CREPIS CAPILLARIS. Batikyan, G. G.; Danielyan, A. Kh.; Martirosyan, S. N.; Karagezyan, A. S. Biol. Zh. Arm.; 21: No. 7, 23-9(Jul 1968). (In Russian).

The modifying action of ATP and kinetin on the radiation injury of cells in seeds of Crepis capillaris following different exposures in these solutions and the effectiveness when applied before or after irradiation was studied. Seeds moistened in 0.016% solution of ATP and 0.05% solution of kinetin reduced the percent of chromosome aberrations to almost one-third that of seeds moistened in water. A linear relation was also noted between the length of treatment and the protective effect of ATP and kinetin. Both pretreatment and posttreatment with these substances gave the same protective effect. It was also shown by the spectrum of aberrations, that all of the disturbances observed in the first division metaphase of cells are of the chromosome recombination type. ATP is synergistically affected by kinetin, which plays an important role in the processes of oxidative phosphorylation. In either pre- or post-radiation treatment, these substances showed equal protective effect, decreasing the yield of chromosome aberrations. (tr-auth)

9878 INFLUENCE OF MEXAMINE ON THE DISTRIBUTION OF ^{35}S-CYSTAPHOS IN THE ORGANISM AND ANALYSIS OF THE PROTECTIVE EFFECT OF A COMPLEX OF THESE PROTECTORS. Airapetyan, G. M.; Yarmonenko, S. P.; Lyarskii, P. P.; Ovakimov, V. G.; Ivanov, V. N. (Inst. of Labor Hygiene and Occupational Diseases, Moscow. Inst. of Experimental and Clinical Oncology, Moscow). Radiobiologiya; 9: 416-20 (1969). (In Russian).

It was shown experimentally that in the case of subcutaneous injection, mexamine exerts a substantial influence on the dynamics of the distribution of radioactive cystaphos in the organs, the maximum effect of which is observed during the first hour. The possibility of enhancing and prolonging the radioprotective action of the mexamine-cystaphos complex was demonstrated. (tr-auth)

9879 RADIOPROTECTIVE EFFECT OF A CHEMICAL MIXTURE IN RATS. Wang, R. I. H.; Hasegawa, A. T. (Veterans Administration Center, Wood, Wis. Marquett School of Medicine, Milwaukee). Radiat. Res.; 40: 310-16(Nov 1969).

Radiation protection in rats has not been as successful as in mice. In this study, a chemical mixture consisting of 5 μmoles of 5-hydroxytryptamine (5-HT), 100 μmoles of 2-aminoethylisothiouronium (AET), and 150 μmoles of mercaptoethylamine (MEA) was shown to protect rats against supralethal doses of x-irradiation. The $LD_{50(30)}$ for the protected rats was 1580 R compared with a value of 860 R for control rats and gave a dose reduction factor of 1.83. The protective effect of this chemical mixture was found to be greater than that of any of the compounds. (auth)

9880 RESIDUAL RADIATION INJURY: HEMATOPOIETIC AND GASTROINTESTINAL INVOLVEMENT IN RELATION TO AGE. Yuhas, John M.; Huang, Donna; Storer, John B. (Jackson Lab., Bar Harbor, Maine). Radiat. Res.; 38: 501-12(Jun 1969).

Residual x radiation injury (the depression in resistance to 140 R/day, 5 days a week) owed to 500 R given 30 days earlier was measured in C57BL/6J female mice between the ages of 3 and 23 months. Control mice (previously unirradiated) demonstrated a parabolic relation between age and resistance to this exposure regimen, whereas preirradiated (500 R) mice demonstrated resistance levels that were inversely related to age. The state of the bone marrow, in terms of endogenous colony-forming unit patterns, in previously unirradiated aging mice correlated with their resistance to fractionated exposures, but it did not predict the inverse age-resistance relation in aging mice given 500 R 30 days earlier. Bone marrow transplantation immediately after a lethal dose of x rays reduced the residual injury detectable in young adult mice that survive for 30 days but did not remove the age-dependence for residual injury induction. Shielding of the trunk during exposure allowed the residual injury measured 30 days later to parallel the state of the bone marrow. It is concluded that the basis of the age-dependence for residual injury induction is not hematopoietic and it is proposed that the basis is the increasing importance of gastrointestinal factors as the age of the mouse increases. In support of this interpretation is the linear decline in the gastrointestinal resistance and recovery potential as a function of age. (auth)

9881 RADIOPROTECTIVE EFFECT OF SODIUM FLUOROACETATE IN MICE. Novak, L.; Sikulova, J.; Hosek, B.; Misustova, J. (Inst. of Biophysics, Brno). Radiat. Res.; 40: 430-9 (Nov 1969).

A quantitative study of the radioprotective effect of sodium fluoroacetate (FAc) in white mice of H-strain, 9 to 12 weeks old was made. The results of the experiments show that FAc administered intraperitoneally 3 hours before irradiation in the amount of 7.5 mg/kg increases the average $LD_{50(30)}$ value from 648 R (controls) to 998 R (protected). A comparison of the obtained results with data on the radioprotective effect of cysteine, cysteamine, AET, serotonin and hypoxia indicates that the radioprotective effect of FAc is not statistically different from the effect of these compounds. The protective effect of FAc, however, requires much smaller doses (50–75 μmoles/kg). At the same time the duration of protection after FAc administration is much longer, lasting roughly from 30 minutes to 7 hours after the application of the substance, with maximum protection between the first and second hour. (auth)

9882 SINGLE-STRAND BREAKS IN DNA OF EHRLICH ASCITES TUMOR CELLS PRODUCED BY METHYL HYDRAZINE. Moroson, H.; Furlan, M. (Sloan-Kettering Inst. for Cancer Research, Rye, N. Y.). Contract AT(30-1)-910. Radiat. Res.; 40: 351-65(Nov 1969).

Methyl hydrazine (MH) is a reducing agent and electron donor previously found to radiosensitize anoxic bacterial cells. This compound has now been shown also to radiosensitize Ehrlich ascites tumor cells in vivo (dose modifying factor of 2) at concentrations non-lethal to cells or the host mouse. When MH-treated Ehrlich ascites cells are layered upon an alkaline sucrose density gradient the resulting DNA profile resembles that of cells receiving a large dose of x-radiation, i.e., a shift toward the top of the gradient, suggesting the production of a great many single-strand breaks. This effect is also observed with nucleoprotein isolated from Ehrlich ascites cells. Incubation of MH-treated cells in saline in the absence of MH allows partial rejoining of single-strand breaks. The normal strand break repair period following radiation injury may be less effective for cells in the presence of MH, possibly explaining the observed radiosensitization effect. (auth)

Radiation Sickness and Injuries

9883 RADIATION INJURIES AND THEIR TREATMENT BY PLASTIC SURGERY. Ugland, Ole M. (Akademiska Sjukhuset, Uppsala). Tidsskr. Nor. Laegeforen., 88: 957-62 (May 15, 1968). (In Norwegian).

From 1952 to 1966 a total of 79 patients were treated for radiation skin damage by plastic surgery. The radiation injury was sustained mostly in individuals 50 to 70 years of age who were treated with x rays to cure a malignant tumor or a benign skin disease. The dose used in treating malignant tumors varied from 1000 to 9000 R. The average time period between the x ray treatment and recognition of subsequent injury was 4 to 5 years. Among patients with a benign skin disease, the subsequent skin cancer appeared on the average 37 years after the x ray treatment. None of the patients who underwent plastic surgery died as a result of skin cancer. It is concluded that plastic surgery is an effective way of treating radiation damage of the skin. (TTT)

Radiodiagnosis

Refer also to abstracts 9639, 9644, 9664, 9735, 9744, 9829, 9831, 9832, and 9963.

9884 (ACRH-1000-154) DETECTION, PREVENTION, AND RETARDATION OF MENOPAUSAL OSTEOPOROSIS. Davis, M. Edward; Lanzl, Lawrence H.; Cox, Ann B. (Argonne Cancer Research Hospital, Chicago, Ill. Chicago Univ., Ill.). [nd]. 10p. (CONF-690633-1). Dep. CFSTI.

From International Symposium on Osteoporosis, Bronx, N. Y.

The correlation of the appearance of osteoporosis with the decline of estrogen production and the incidence of the disorder in the United States are discussed. Difficulties in measuring bone densities by standard methods are pointed out. A new device, using a finely collimated beam of ^{125}I γ radiation, and based on the fact that there is a direct ratio of the mineral content of the phalanges to that of the spine and pelvis, was developed for determining bone density. The operation of the device, using a patient's finger, is described and advantages are pointed out. Studies on two groups of patients, one with estrogen replacement therapy and the other without therapy, showed that estrogen therapy retarded the rate of development of osteoporosis in postmenopausal females. Another instrument, using ^{241}Am for determining bone density, is described; new possibilities for research on bone metabolism are offered by this instrument. (H.L.W.)

9885 (CONF-690303-, pp 1-19) THE ATOM'S EXPANDING ROLE IN THE MEDICAL WORLD. Seaborg, Glenn T. (Atomic Energy Commission, Washington, D. C.).

Recent progress in the medical applications of the atom are discussed. Among these areas involving the direct application of radioisotopes in medical procedures and techniques are included the use of ^{60}Co and ^{137}Cs as γ sources in cancer radiotherapy; ^{131}I in radiodiagnosis of thyroid diseases; ^{14}C to study metabolic aberrations; ^{68}Ga, ^{85}Sr, ^{87m}Sr, ^{18}F, and ^{47}Ca in bone scanning; ^{51}Cr to measure cell mass; ^{74}As and ^{197}Hg in brain tumor localization; ^{90}Yb in pituitary gland radiotherapy; ^{198}Au as a palliative in lung cancer; ^{197}Hg and ^{203}Hg for renal function testing; ^{75}Se for pancreas scanning; ^{22}Na and ^{24}Na for diagnosing circulatory disorders; ^{32}P for therapy of blood disorders; ^{55}Fe and ^{59}Fe for studying intestinal absorption and erythrocyte kinetics; ^{57}Co and ^{60}Co for vitamin B_{12} absorption tests; ^{67}Ga for localization of Hodgkin's disease lesions; ^{99m}Tc for an ever-increasing array of liver, spleen, and bone marrow studies; and a variety of cyclotron-produced short-lived radioisotopes, including ^{11}C, ^{13}N, ^{15}O, and ^{18}F, for tracer studies where adequate activity is required, but limited radiation exposure of the patient is essential. A number of improvements in the instrumentation and techniques of medical radioisotope applications are given including: clinical radioisotope scanning techniques; in vitro diagnostic procedures; semiconductor-detector probes; whole-body counters; teletherapy techniques; brachytherapy procedures; extra-corporeal irradiation techniques; low dose-rate facilities; techniques for suppression of immune response in transplantation procedures; radioisotope-powered pacemaker systems; and ultimately radioisotope-powered artificial hearts. A vast amount of information obtained as an indirect result of nuclear-medical research is being compiled as in the case of our better understanding of the natural aging process in man, an indirect benefit derived from the ABCC studies in Hiroshima and Nagasaki. Technological spin-offs have also played an important role in expanding our horizons in biological research. Examples of this are the development of zonal centrifugation technology for molecular research, application of the electronic scanner-analyzer in karyotype analysis, and application of neutron activation techniques in trace element studies. (E.R.B.)

9886 A PHYSIOLOGICAL MODEL FOR THE RENAL EXCRETION OF LABELED COMPOUNDS. Farmelant, Melvin H.; Sachs, Charles E.; Genna, Sebastian; Burrows, Belton A. (Boston Veterans Administration Hospital. Boston Univ.). J. Nucl. Med.; 10: 664-71(Nov 1969).

Following ^{131}I-hippuran injection, renal curves, urine concentration, and bladder radioactivity curves were related to arterial blood concentration curves. Renal uptake, until emptying begins, and bladder accumulation closely approximate the integral of arterial blood concentration. The difference between the integral of blood concentration (renal uptake) and bladder (integrated renal losses) approximates the net kidney curve after loss from the kidney begins. Likewise, the difference between renal radioactivity and the integral of blood concentration yields the original integral curve of arterial blood concentration. The curve from a nonobstructed kidney with adequate urine flow can be expressed as the integral of blood concentration minus the same integral displaced in time (time of passage of radioisotope through the kidney). It was concluded that with adequate urine flow rates the rate of fall as well as the rate of rise of the kidney curve reflects the rate of fall in arterial blood concentration; moreover, the passage of radioisotope through renal tubule and pelvis involves little mixing. Differences between the kidneys in retention of radioisotope reflect both differences in passage time and often marked unilateral reduction of urine flow rate. (auth)

9887 TRANSMISSION TECHNIQUE USED FOR POSITIONING FOR CEREBRAL BLOOD FLOW. Jump, Barbara J. (North Charles General Hospital, Baltimore). J. Nucl. Med.; 10: 708 (Nov 1969).

A method is described for positioning the head of a patient prior to scanning for blood circulation using ^{99}Tc using a γ camera. (C.H.)

9888 MAPPING MYOCARDIAL MASS AND REGIONAL CORONARY BLOOD FLOW BY EXTERNAL MONITORING OF ^{42}K OR ^{86}Rb CLEARANCE. Love, W. D.; Smith, R. O.; Pulley, P. E. (Univ. of Mississippi, Jackson). J. Nucl. Med.; 10: 702-7(Nov 1969).

The use of ^{42}K or ^{86}Rb for scanning the heart of dogs and man was investigated. Myocardial mass and regional cornary blood flow were demonstrated following intravenous administration of the tracer. It was necessary to design special shields and collimators for use with scintillation detectors used for scanning. Best results were obtained when the counts detected by an opposing pair of probes were analyzed by a computer. The method was more satisfactory in the dog than in man. (C.H.)

9889 /sup 99m/Tc-FERRIC HYDROXIDE MACROAGGREGATES FOR PULMONARY SCINTIPHOTOGRAPHY. Yano, Yukio; McRae, James; Honbo, Deanna S.; Anger, Hal O. (Univ. of California, Berkeley). J. Nucl. Med.; 10: 683-6(Nov 1969).

The physical advantages of ^{99m}Tc can be used for lung scanning with this new compound, $^{99m}Tc-Fe(OH)_3-MA$, which is easily and rapidly prepared. There is about 85% uptake of ^{99m}Tc in the lungs with insignificant uptake in other organs. The high photon yield and low radiation dose permits lung scans to be performed in a few minutes and dynamic blood-flow studies are possible with the scintillation camera using 2 to 3-sec exposures. (auth)

9890 THE LUNG SCAN IN alpha$_1$-ANTITRYPSIN DEFICIENCY. Welch, Martin H.; Richardson, Robert H.; Whitcomb, Walter H.; Hammarsten, James F.; Guenter, Clarence A. (Univ. of Oklahoma, Oklahoma City. Veterans Administration Hospital, Oklahoma City). J. Nucl. Med.; 10: 687-90(Nov 1969).

Ten patients with pulmonary emphysema associated with hereditary antitrypsin deficiency were studied with ^{131}I-albumin macroaggregate lung scans. These patients were clinically similar in that they presented the syndrome of primary emphysema as opposed to chronic bronchitis. There was a wide range of severity of disease, however. All patients studied had a bilateral decrease in perfusion to the lower lung fields. This similarity within a group of patients is in contrast to the variability in lung-scan patterns previously described in heterogeneous populations of emphysema patients. This characteristic lung-scan appearance should be helpful in identifying patients with antitrypsin deficiency. (auth)

9891 TRUNCATED LEFT HEPATIC LOBE: A SIGNIFICANT LIVER SCAN ABNORMALITY. Johnston, Gerald S. (Letterman General Hospital, San Francisco); Jones, A. Eric. J. Surg. Oncol.; 1: No. 2, 109-14(1969).

Three cases involving the appearance of truncated left hepatic lobe are presented to illustrate the appearance of this abnormal condition on liver scintiscanning. The presence of the truncated lobe on the liver scan is probably the result of tumor interference with the blood supply to the left lobe. (E.R.B.)

9892 SIGNIFICANCE AND EVALUATION OF A PROCEDURE FOR THYROID DIAGNOSIS. Meng, W.; Meng, S.; Knoke, M.; Hendrik, A.; Maennchen, E.; Baufeld, W. (Univ., Greifswald, Ger.). Deut. Gesundheitsw.; 24: 2023-7(23 Oct 1969). (In German).

The diagnostic reliability of the laboratory methods available to us (radioiodine tests, PBI, serum lipids, metabolism, specific-dynamic protein effect, medium acral re-warming period, and static and dynamic achilles sinew reflex period (ASRZ)-measurement) were investigated in a selected number of patients (912 eu-, 93 hyper-, and 44 primary hypothyreoses). For the detection of the hyperthyreoses only the radioiodine test was of great diagnostic reliability. As far as the other methods are concerned, the determination of the metabolism that was carried through very exactly, could be utilized most frequently. A simple and reliable search test is not available. With regard to the diagnosis hypothyreosis, the ASZR, especially the dynamic ASRZ-measurement, and the radioiodine test were by far superior to the other methods. The ASRZ-recording constitutes a genuine screening

test. The results of the PBI determination with all patients selected were conspicuously poor. Possibilities of errors of all methods are discussed. (auth)

9893 ISOTOPE QUANTITATION OF AORTIC INSUFFICIENCY COMPARED TO CINEANGIOGRAPHY IN MAN. Hildner, Frank J.; Pierson, William R.; Barold, S. Serge; Linhart, Joseph W.; Samet, Philip (Mt. Sinai Hospital of Greater Miami, Miami Beach, Fla.). Ann. Thorac. Surg.; 8: 84-93(Jul 1969).

Aortic valve regurgitation was measured by isotope dilution, using ^{99}Tc–sodium pertechnetate, and contrast aortography in 30 patients with aortic valve disease only. The ranges of regurgitant flow described by the four grades of aortic valve insufficiency (AI) were considerably different from one another. Although the 1+, 2+, and 3+ grades of AI can be distinguished, the 3+ and 4+ grades overlap widely and are largely indistinguishable. A limited correlation between degree of AI and aortic diastolic pressure was shown better by isotope AI than by angio AI. No difference between these methods was shown when they were compared to left ventricular end-diastolic pressure or cardiac index. The isotope method is tolerated better than angiography, has fewer side effects, avoids the possibility of allergic reaction, and does not alter the steady state. Isotope measurement of AI is an excellent alternative method to angiography and, in combination, is complementary to angiography. (auth)

9894 INTERRELATIONSHIP BETWEEN HYDRATION, URINE FLOW, RENAL BLOOD FLOW, AND THE RADIOHIPPURAN RENOGRAM. Razzak, Muhammad A.; Botti, Robert E.; MacIntyre, William J. (Case Western Reserve Univ., Cleveland). J. Nucl. Med.; 10: 672-5(Nov 1969).

Hydration had no consistent effect on the time required for the occurrence of the initial rise of radioactivity recorded during radioisotope renography. In contradistinction, the slope of the ascending limb became steeper and radioactivity reached peak value at an earlier time. The early portion of the descending limb became steeper, whereas the final part became flatter. These changes cannot be explained by alteration in the renal blood flow since hydration did not cause any constant effect on the total renal blood flow. Furthermore, the slope of the ascending limb of the renogram cannot be used to calculate the relative blood flow to each kidney. The advantages of recording the radiohippuran renogram under hydration consist of better equalization of the counting rates over the renal areas at the time of peak activity and elimination of the stepwise descent in radioactivity. In addition, there can be a more readily identified point of intersection of the initial rise of radioactivity and the succeeding ascending limb of the renogram. The effect of bladder radioactivity on the counting rates recorded by the renal detectors is shown. (auth)

9895 CURRENT STATUS OF DUAL-CHANNEL PANCREAS SCANNING. Fink, Sidney; Ben-Porath, Moshe; Jacobson, Burton; Clayton, Glenn D.; Kaplan, Ervin (Veterans Administration Hospital, Hines, Ill. Loyola Univ. Stritch School of Medicine, Hines, Ill. Univ. of Illinois Coll. of Medicine, Chicago). J. Nucl. Med.; 10: 78-82(Feb 1969).

The dual-channel scanning technique, using ^{198}Au-colloid and ^{75}Se-selenomethionine, was applied to the diagnosis of pancreatic disease and found helpful. Distinct patterns were discernible in individuals free of pancreatic disease, patients with carcinoma of the pancreas and patients with chronic pancreatitis. With the exception of a visualized spleen, an appearance similar to that of carcinoma of the pancreas was found in patients with cirrhosis. The implications are discussed, and the need for caution in interpreting pancreatic scans in these individuals is stressed. (auth)

9896 ^{51}Cr LUNG SCAN IN IDIOPATHIC PULMONARY HEMOSIDEROSIS. Samuels, Larry D.; Bass, Jack C. (Children's Hospital, Columbus, Ohio. Ohio State Univ., Columbus). J. Nucl. Med.; 10: 106-7(Feb 1969).

The use of ^{51}Cr for lung scanning to identify pulmonary sequestration of red blood cells and to support the diagnosis of idiopathic pulmonary hemosiderosis is reported. The case of a 14 yr old girl with a history of upper respiratory infection is described. Following transfusion of ^{51}Cr-labeled blood cells, thoracoabdominal scans were performed and counting rate was recorded over the spleen, liver, heart, and lungs. The scan revealed significant migration from the spleen and liver and vascular structures of the heart and mediastinum into the peripheral lung fields, providing graphic evidence of sequestration in the lung parenchyma, indicating idiopathic pulmonary hemosiderosis. A subsequent lung biopsy revealed changes typical of idiopathic pulmonary hemosiderosis, confirming the impression obtained with the procedure of ^{51}Cr lung scanning. (H.L.W.)

9897 RADIOIZOTOPNOE SKENNIROVANIE. (Radioisotope Scanning). Abdurasulov, D. M.; Muratkhodzhaev, N. K. Tashkent; Izdatel'stvo Meditsina Uz SSR (1968). 360p.

Various aspects of the wide range of studies made possible by radioisotopic scanning are reviewed. The physicotechnical development of radioisotope scanning devices and methods are described. Scanning of the central nervous system, thyroid glands, lungs, and heart are discussed in detail. Extensive references to Soviet and Western published literature are included. (R.V.J.)

9898 SCREENING OF RENOVASCULAR HYPERTENSION BY MEANS OF THE SCINTILLATION CAMERA. Ziliotto, D.; Ferlin, G.; Vianello, A. (Univ., Padua). Acta Isotop.; 8: 325-39(15 Dec 1968). (In Italian).

Ten patients with renovascular hypertension were studied by radioisotope scanning using a scintillation camera. The renographic sequence with ^{131}I-hippuran was carried out in all of them and the ^{99m}Tc-pertechnetate angiography was performed in five cases. The most frequent and characteristic change observed in the ^{131}I-hippuran was carried out in all of the appearance phase, associated with a small-sized and often hypoactive renal image. The study with ^{99m}Tc gave more striking evidence of the reduced blood flow on the side of the stenotic artery. (auth)

9899 CONTRAST ENHANCEMENT OF SCINTIGRAMS AND CAMERA-SCINTIPHOTOS OF DIFFERENT ORGANS USING A CLOSED CIRCUIT TV SYSTEM. Ziliotto, D.; Ferlin, G.; Macri, C.; Vianello, A. (Univ., Padua). Acta Isotop.; 8: 341-54(15 Dec 1968). (In Italian).

The TV re-examination of radioisotope scans appears to be particularly useful in the evaluation of heart scintigrams, as well as in the detection of space occupying lesions of liver, spleen, lungs, and sometimes of the thyroid also. Less significant results are obtained in brain, kidney, and pancreas scans. In the case of the camera-scintiphotos, the TV system seems to offer a definite advantage in the re-examination of all organs. The pictures, in fact, can be not only appropriately contrasted but also presented in a life size. (auth)

9900 THE VALUE OF THE SCINTILLATION CAMERA IN THE DIAGNOSIS OF RENAL DISEASES. Ferlin, G.; Ziliotto, D.; Vianello, A. (Univ., Padua). Acta Isotop.; 8: 371-400(15 Dec 1968). (In Italian).

The results of gamma camera renograms with ^{131}I-hippuran in 165 patients are presented, 36 of whom were normal, 74 of whom had different kidney conditions, and 55 of whom were hypertensive patients. The examination was carried out in a sitting position and following a normal water intake. In 15 cases a second examination was performed with the patient in prone position, and in 18 cases during water-induced diuresis. The main changes showed by the scintiphotographic sequence included acute and chronic glomerulonephritis, marked delay of cortical transit time; chronic pyelonephritis, delay in the cortical transit often associated with delayed pelvic drainage and, in the more severe cases, important changes of the renal images; obstructive uropathies, marked delay in the excretion or progressive pooling of radioactivity in the pelvis and in the case of low level obstruction a visualization of the enlarged ureter was observed; and for non-renal hypertension, in two thirds of cases variable changes, usually of moderate degree were seen. The most frequent change observed was a unilateral or bilateral delay in the appearance phase. The findings observed in other nephropathies such as tumors, cysts, and malformations are also described. (auth)

9901 LIVER EXAMINATION BY THE SCINTILLATION CAMERA. Ziliotto, D.; Ferlin, G. (Univ., Padua). Acta Isotop.; 8: 355-70(15 Dec 1968). (In Italian).

Anger's scintillation camera was employed in liver examinations with ^{99m}Tc-sulfur colloid and with ^{131}I-rose bengal. Satisfactory images were obtained using ^{99m}Tc and collecting 500 to 600,000 dots with an exposure time of 20 to 60 seconds. It was possible to carry out a complete liver evaluation in all three projections within three to five minutes. In normal subjects the spleen was usually scarcely recognizable in the anterior view, whereas it was clearly visualized in the posterior view. Structure and morphologic changes of the liver in different conditions were shown with an accuracy which is not inferior to that of the conventional scanning technique. Using ^{131}I-rose bengal a morphological and functional study of the liver can be carried out by means of a sequence of images which may show the entire excretion process of the dye. The method may yield interesting results both in the study of liver cirrhosis and in the differential diagnosis of jaundice. (auth)

9902 TUMOR SCANNING WITH ^{67}Ga CITRATE. Edwards, C. Lowell; Hayes, R. L. (Oak Ridge Associated Universities, Tenn.). J. Nucl. Med.; 10: 103-5(Feb 1969).

The characteristics of ^{67}Ga as a diagnostic scanning agent are discussed. Ten patients with Hodgkin's disease and other soft-tissue tumors were given intravenous injections of ^{67}Ga and 24 hours later whole-body scans were performed. Distinct localization of ^{67}Ga in known and presumed tumor was seen in three of four patients with Hodgkin's disease, and three of four patients with other types of lymphoma. An additional patient with a poorly differentiated carcinoma of the thyroid with pulmonary metastases was studied to test the ^{67}Ga preparation in nonlymphomatous tumor. A whole-body scan 24 hr after the intravenous administration of 2.5 mCi of carrier-free ^{67}Ga showed that most of the isotope was present in the pulmonary metastases. Findings suggest that ^{67}Ga may be a valuable scanning agent for the detection of soft-tissue tumors. (H.L.W.)

Radiotherapy

Refer also to abstracts 9552, 9790, 9953–9960, and 9964.

9903 (AD-693104) METABOLIC CHANGES IN HUMANS FOLLOWING TOTAL-BODY IRRADIATION. Annual Report, May 1, 1966–April 30, 1967. Saenger, Eugene L.; Friedman, Ben I.; Horwitz, Harry; Kereiakes, James G.; Perry, Harold (Cincinnati Univ., Ohio. Coll. of Medicine). 1967. Contract DA-49-146-XZ-315. 54p. (DASA-2179). CFSTI.

Clinical observations in three patients treated with 100 to 200 rad partial-body radiation to the lower body and one patient treated with 150 rad total-body radiation have parallel observations previously reported. A simple infusion filtration system for reinfusion of human bone marrow has been made. A rapid and sensitive assay method for urinary deoxycytidine which allows the detection of as little as a microgram of CdR in one ml of urine has been developed. Two separate strains of phage to be used for antibody titration are being grown on synthetic culture media. (auth) (TAB)

9904 HYBAROXIC RADIOTHERAPY OF LESIONS OF OROPHARYNX. Wildermuth, O. (Swedish Hospital Medical Center, Seattle). Nunt. Radiol.; 34: 227–44(Mar 1968).

Results of hybaroxic radiotherapy in the treatment of 192 patients with cancer of the head and neck, with lymph node metastases in 84 instances, are presented. Initially the program called for six irradiation sessions over a 30-day period, a 600-rad absorbed dose in the tumor-bearing area, for a total of 3600 rad in 4 weeks. This seemed a modest dose. However, when it was given in this manner there was a high rate of necrosis in the intervening tissues. After this experience, the present program calls for eight treatment sessions in hybaroxia of 500 rad each, in the target area, over a period of 4 weeks. This seems to preserve the therapeutic ratio, and, when evaluated by the Ellis technique, falls within the curative range. The 2-yr follow-up study on 118 patients of risk for this period indicated a crude survival rate of 46%. While this does not satisfy the classic 5-yr survival criterion, there was good reason to assume that 2-yr survival reflects a cure in cancers in this area. Lymph node metastases in the cervical region were eliminated and remained absent in 20 of 41 instances. There seemed to be no relation of success to whether the nodes were fixed or not. Recurrence in the extensive scar following neck dissection of radical surgery posed a treatment problem unsolved by hybaroxic radiotherapy. These results of hybaroxic radiotherapy were disappointing since the improvement did not parallel the frequency of central necrosis demonstrable microscopically in specimens of squamous cell carcinoma. If anoxia of viable and survivable cancer cells is corrected by hyperbaric oxygen, then other factors are of great importance in recurrence after treatment of cancer in this area. Hybaroxia may prove to be a refinement rather than a revolution in radiation therapy of cancer. (BBB)

9905 TECHNIQUE AND RESULTS OF RADIOTHERAPY AIDED BY ARTERIAL INFUSION OF HYDROGEN PEROXIDE. Whittle, R. J. M. (St. Bartholomew's Hospital, London). Nunt. Radiol.; 34: 191–205(Mar 1968).

The cannulation and use of the principal artery to a tumor to infuse a neoplasm with hydrogen peroxide and thus enhance the effect of radiotherapy are demonstrated. This intra-arterial technique allows a higher pO_2 locally throughout the tumor target. Hydrogen peroxide, when infused into an artery, is immediately destroyed by catalase, which degrades H_2O_2 to molecular oxygen and water. In eight cases, the catheter was inserted through the superficial temporal artery to treat cancers of the tongue, antrum, upper alveolus, lower alveolus, and nasal passage. The cancer was not controlled in five cases after radiation doses of 3000 to 6000 rad. In three other cases, the catheter was inserted through the superior thyroid artery to treat cancers of the floor of the mouth or tongue. The cancers were controlled in two cases. Complications of treatment that may result in patients with acatalasia and deficiency of the enzyme glucose-6-phosphate dehydrogenase are discussed. The infusion of hydrogen peroxide in the latter condition will be followed by a hemolytic anemia. There is also the theoretical risk that in the red blood cell the hemoglobin may be oxidized by hydrogen peroxide to methemoglobin. In practice, any rise in the methemoglobin level is quickly corrected by methemoglobin reductase, so that the normal level of methemoglobin is maintained below 0.1%. Blood levels of methemoglobin were measured 30 min after the completion of H_2O_2 infusions and found to be within the normal range. One patient irradiated for a carcinoma of the floor of the mouth developed, 4 yr later, ischemic necrosis of the right half of the tongue and a segment of the mandible. After several weeks the lingual slough separated and mucosal regeneration occurred, but necrosis of the mandible persisted. (BBB)

9906 ASSOCIATION OF METHOTREXATE WITH RADIATION IN THE TREATMENT OF HEAD AND NECK CANCER. Conte, Gianni; Casara, Silvio; Grigoletto, Eligio; Ruffato, Cesare (Ospedale Civile, Padua). Tumori; 55: 95–102(Mar–Apr 1969). (In Italian).

A possible synergistic effect of ^{60}Co γ radiation was studied in 20 patients affected by advanced head and neck malignancies treated by a combination of oral Methotrexate and radiotherapy. The techniques used and the immediate and short-term results are reported. The weekly dose of γ radiation was 1000 to 1250 rad given in five sessions, for a total of 2500 to 3000 rad in 10 patients and 5500 to 6000 rad in 10 others. Toxic effects of Methotrexate (1 mg/Kg) were noted, such as mucositis, leukopenia, and thrombocytopenia, that occasionally required cessation of treatment. The best regimen, it is suggested, is to begin with the drug and then to use irradiation. Results are satisfactory when compared with those obtained by surgery or radiotherapy alone, and tolerance to the two modalities is generally good. Complete regression of the tumor was noted in four patients given the lower radiation dose and in five given the higher dose. The mean survival time was 8.8 months. (BBB)

9907 CLINICAL APPLICATIONS OF PHYSICS OF RADIOLOGY AND NUCLEAR MEDICINE. Bogardus, Carl R. Jr. A Monograph in Modern Concepts of Radiology, Nuclear Medicine, and Ultrasound. St. Louis, Warren H. Green, Inc., 1969. 246p. $12.75.

Concepts of radiation physics applicable in radiology and nuclear medicine are reviewed for the physician with little or no training in radiation physics. Topics discussed include basic electricity; basic electronics; x ray circuits; atomic structure and radiations; definitions of radioactive radiations; the use of radium in therapy; interactions of radiation with matter; factors influencing film quality in diagnostic radiography; radiation therapy using ^{137}Cs or ^{60}Co γ, interstitial radium γ, or supervoltage x radiation; uses of radioisotopes in diagnosis and therapy; and radiation dosimetry for externally and internally administered radiations. (21 references.) (C.H.)

Blast and Thermal Effects

Refer also to abstract 9806.

9908 (CONF-690303–, pp 307-17) DELAYED RADIATION EFFECTS AMONG JAPANESE SURVIVORS OF THE ATOMIC BOMBS. Miller, Robert W. (National Cancer Inst., Bethesda, Md.).

In a study of 70,000 children conceived after the explosions, six indicators of genetic damage failed to reveal an unequivocal effect of radiation. Furthermore, this group displayed no evidence of cytogenetic abnormality, in contrast to the increased frequency of chromosomal aberrations found among those exposed in utero or at any time during the entire life span. The effect was most pronounced among persons whose exposures occurred when they were 30-years of age or older. The only effect of intrauterine exposure was a small head circumference with mental retardation. Studies on leukemogenesis showed that the effect was proportionate to the dose, that the peak occurred about 6 yr after exposure, and that an increase occurred in acute leukemias and chronic granulocytic leukemia, but not in the chronic lymphocytic form of the disease. Increases in other cancers, including breast cancer and lung cancer, were reported recently among Japanese survivors. (H.L.W.)

Radiation Effects on Animals

Refer also to abstracts 9771, 9796, and 9882.

9909 REPAIR OF SUB-LETHAL AND POTENTIALLY LETHAL RADIATION DAMAGE IN PLATEAU PHASE CULTURES OF HUMAN CELLS. Little, J. B. (Harvard Univ., Boston). Nature (London); 224: 804-6(22 Nov 1969).

The effects of radiation on stationary cultures of a line of cells derived from normal human liver are described. After irradiation in the plateau phase not only did these cells recover from sub-lethal radiation damage, but potentially lethal damage was repaired if the cells were allowed to remain in the stationary phase for some time after irradiation. The mean survival parameters from data derived from a number of consecutive experiments in which cells were irradiated in each growth phase are shown; the slopes of the corresponding survival differed significantly. The results of an experiment in which replicate cultures were irradiated with 400R, returned to the incubator for up to 6 hours, then exposed to trypsin and plated for colony-forming ability are also shown graphically; survival was enhanced by a factor of about two when 2 to 6 hours elapsed between irradiation and plating. Enhanced survival was not observed when a similar experiment was performed with exponentially growing cultures. The survival curve for stationary cultures of liver cells had an extrapolation number significantly greater than unity; hence these cells should also be able to accumulate and repair sub-lethal radiation damage. The effects of recovery from both potentially lethal and sub-lethal damage on net cell survival after a split radiation dose are also shown; the net survival with the split dose was about six times greater than when the same dose was given as a single exposure. Various factors, however, including cell type, appear to influence the radiation response in plateau phase cultures. The type of serum in which cells are irradiated may also affect results. Caution is therefore emphasized in extrapolating results obtained with plateau phase cultures of any particular cell line grown in specific cultural conditions to the in vivo situation. If the ability of stationary cells to repair radiation damage that would usually be lethal to actively proliferating cells is a general phenomenon, however, this factor could be important in the net response of human malignant tumors to fractionated radiotherapy. (UK)

9910 ANALYSIS IN VITRO OF GROWTH AND SECRETION OF THE MOUSE SUBMANDIBULAR AND SUBLINGUAL RUDIMENTS, SUBJECTED TO X-RAYS. Borghese, E.; Di Giovine Vecchione, L. (Univ., Naples). Contract 043-65-1 BIOI. Radiat. Res.; 38: 389-403(May 1969).

The effect of x irradiation in vitro with 25 to 500 R on the development of isolated submandibular and sublingual glands of the mouse was studied on explants at the thirteenth day of gestation, incubated on a clot of chick plasma and embryo extract. Growth was quantitatively estimated by counting epithelial buds formed during 48 hours of culture in controls and irradiated glands. The average number of counts was plotted against the dose, in order to construct a dose-effect curve and a regression line. Growth was found to be progressively inhibited with doses of radiation increasing from 100 to 500 R. However, an anomaly was observed in the range between 25 and 100 R, where a lower dose seemed to have a stronger inhibiting effect than a higher one. This rather surprising and apparently significant effect was consistently obtained in two different sets of experiments. Secretion was studied in two conditions: (1) by radiation applied at explantation time, and histological study in the following 5 days of culture, and (2) by radiation applied after 3 days of culture, when the glands have either just begun to secrete, or after 5 days when they have already progressed to secrete, and examination after 1 or 2 days of further cultivation. In both cases, the synthesizing activity of cells, expressed by the appearance of secretion, seemed to be related neither to the age nor to the dose applied, but only to the degree of development of acini. On the other hand, no significant qualitative change in secretion could be detected by the methods applied. (auth)

9911 OXYGEN ENHANCEMENT RATIO AND RBE OF HELIUM IONS ON MOUSE LYMPHOMA CELLS. Feola, Jose M.; Lawrence, John H.; Welch, Graeme P. (Univ. of California, Berkeley). Radiat. Res.; 40: 400-13(Nov 1969).

Survival of mouse lymphoma cells irradiated under hypoxic and hyperoxic conditions has been used to calculate the oxygen enhancement ratio (OER) and the relative biological effectiveness (RBE). X rays at 230 kV and ^{4}He ions of four different linear energy transfers (LET) from the 184-inch synchrocyclotron and the 88-inch sector-focused cyclotron have been used. For x-rays and Bragg curve "plateau" ^{4}He ions of relatively low LET (17 and 80 MeV-cm^2/g), the OER changes very little, ranging from 3.2 to 3.5. Higher LET particles, however, in the vicinities of the Bragg peaks with average LET's of 180 and 220 MeV-cm^2/g are more effective under anoxic conditions so that the OER is less, 1.8 and 2.1. The RBE's were also higher, 1.8 and 1.9, with higher LET particles and hypoxic lymphoma cells but with low LET and either hypoxic or hyperoxic cells the RBE's were all quite close to 1.0. An estimate of the decrease of oxygen effect for a particular radiation can be had from the gain factor, the ratio of OER's (x-ray/^{4}He ions). The value of 1.5 for Bragg peak particles from the 184-inch synchrocyclotron and also the RBE of 1.8 are of particular interest because of the use of this radiation for therapy. (auth)

9912 ULTRAVIOLET-LIGHT IRRADIATION ON MOUSE L CELLS: EFFECTS ON CELLS IN THE DNA SYNTHESIS PHASE. Domon, M.; Rauth, A. M. (Univ. of Toronto). Radiat. Res.; 40: 414-29(Nov 1969).

Damage produced by low exposures of ultraviolet-light (uv) irradiation exerts a specific effect on mouse L cells during their passage through their first S phase after irradiation. Previous results showed that irradiation of a synchronized cell population occupying late G_1 to early S phase with 40, 100, or 200 ergs/mm^2 of uv resulted in mitotic delays of 1–2, 4, or 10 hours. In the present work these delays are shown to be chiefly due to delays in cell progression through S phase. Most of the cells undergoing mitotic delay are able to form colonies. However, when irradiated cells occupying S phase are immediately incubated in the presence of 2 mM caffeine, their ability to form colonies is rapidly reduced. This concentration of caffeine does not show any killing effect on cells irradiated in G_2 phase during a corresponding period of incubation. Conversely, caffeine has little effect on cells irradiated in late G_1 or early S phase if the cells are incubated in its absence for 10 hours before being plated in its presence. Cells irradiated in middle or late S phase and incubated for the remainder of their passage through the DNA synthesis period in the absence of caffeine partially lose their sensitivity to caffeine. These observations are consistent with a model in which cells modify uv damage during replication of their DNA and caffeine interferes with this modification process. (auth)

9913 RADIOSENSITIVITY OF SYNCHRONIZED MAMMALIAN CELLS TO LOW-VELOCITY ELECTRONS. Zermeno, Alfonso. Houston, Tex.; Univ. of Texas Graduate School of Biomedical Sciences (1968). 76p.

Thesis.

The radiosensitivity of synchronized Chinese hamster cells to low-velocity electrons and the dependence of sensitivity on electron range were studied. Radiosensitivity versus energy range relationships were employed to determine localization of radiosensitive structures within the cell. Results were compared with studies using mathematical models. (TSS) (Diss. Abstr.)

9914 THE EFFECT OF LASER BEAM ON EHRLICH ASCITES TUMOR CELLS IN VITRO. Mester, Endre; Sellyei, Mihaly. Orv. Hetil., 109: 2551-2(Nov. 17, 1968). (In Hungarian).

The effect of low-energy, up to 1 Joule/cm^2, ruby laser beam on the Ehrlich ascites tumor in mice was studied by exposing the tumor cells to a coherent, 6948 Å wavelength light beam emitted in 0.5-msec pulses. The study included the determination of the growth rate of the tumor, the survival rate of the animals and the mitotic index of mice which have been injected intraperitoneally by the irradiated cell suspension. It was found that the tumors generated by the irradiated transplanted cells grew faster than those due to unirradiated cells. None of the animals in the laser-irradiated group survived 17 days; the control animals died on the 25th day. The mitotic index was higher in the case of tumors due to irradiated cells. The in-vitro irradiation is assumed to excite the in-vivo growth of subsequent generations. The nature of this effect has not yet been established. (TTT)

9915 IRREPARABLE INJURY PRODUCED BY X-IRRADIATION OF RAT THYMOCYTES IN VITRO. Jackson, Kenneth L.; Christensen, Gerald M.; Bistline, Robert W. (Univ. of Washington, Seattle). Radiat. Res.; 38: 560-8(Jun 1969).

The extent to which rat thymocytes are capable of recovery from radiation injury as measured by several criteria was investigated. Incorporation of adenine-8-^{14}C into nucleic acids was depressed by 100 and 50 R, and there was no evidence of recovery of this process within 30 hours after irradiation. Fractionated irradiation with 2 hours between exposures did not reduce the damage to adenine incorporation produced by the same total dose given as a single exposure. Depression of adenine incorporation into nucleic acids and cell survival decreased exponentially as a function of radiation dose, which also suggests that the potential for recovery of radiation injury is absent in mature thymocytes. (auth)

9916 RADIATION-INDUCED MITOTIC DELAY IN CULTURED MAMMALIAN CELLS (L5178Y). Doida, Y.; Okada, S. (Univ. of Rochester Medical Center, N. Y.). Radiat. Res.; 38: 513-29(Jun 1969).

X radiation-induced mitotic delay of exponentially growing populations (immediate decline of mitotic index followed by recovery of mitotic index) was studied in cultured mouse leukemic (L5178Y) cells by using five different methods of localizing the site of the radiation-induced block of cell progress in their life cycle. This was compared with the site of the blocks caused by actinomycin D and puromycin and with the time of switching-off of RNA synthesis. It was found that the x-ray block induced by 200 rads occurred in the middle of the G_2 stage; the puromycin-induced block (10 μg/ml) also occurred in the middle of the G_2 stage; however, the actinomycin D-induced block (0.5 μg/ml) was localized somewhere at the late S or in the early G_2 stage. The switching-off time of RNA synthesis was about 10 minutes before the end of the G_2 stage. In the recovery phase of mitotic delay, actinomycin D (0.5 μg/ml), ouabain (10^{-4} M), and dinitrophenol (10^{-4} M) failed to interfere with the reappearance of mitotic cells, but puromycin (10 μg/ml) significantly interfered with recovery from the mitotic block. From these results, it is concluded that radiation-induced mitotic delay is caused by a complete but transient blockage of cell progress in the middle of the G_2 stage, and it is speculated that radiation-induced mitotic delay involves inhibition of protein synthesis. (auth)

Invertebrates

Refer also to abstracts 9743, 9753, 9805, 9817, 9978, and 9983.

9917 EFFECTS OF RADIOTOXINS ON THE DEVELOPMENT OF SEA URCHIN EMBRYOS. Vainson, A. A.; Merkulov, A. S.; Kuzin, A. M. (Inst. of Biological Physics, Pushchino-on-Oka, USSR). Radiobiologiya; 9: 457-9(1969). (In Russian).

The effects of radiotoxins isolated from irradiated corn seedlings on the development of sea urchin embryos were investigated. The radiotoxins were purified by successive chromatography on columns of DEAE and G-10 sephadex. When added to water in amounts from 35 μg/ml and above, radiotoxins lead to a stoppage of development and death of the embryos. In a concentration of 35-250 μg/ml, radiotoxins stop development at the stage of the early or middle gastrula. (tr-auth)

9918 AN ULTRAVIOLET MICROBEAM STUDY OF THE ROLES OF NUCLEUS AND CYTOPLASM IN DIVISION DELAY, KILLING, AND PHOTOREACTIVATION OF AMOEBA PROTEUS. Jagger, J.; Prescott, D. M.; Gauiden, Mary Esther (Oak Ridge National Lab., Tenn.). Exp. Cell Res.; 58: No. 1, 35-54(Nov 1969).

The relative roles of the nucleus and cytoplasm in whole-cell uv irradiation effects were studied. Starved G_2 cells of Amoeba proteus were flattened to a thickness of 20 μ and irradiated with microbeams of polychromatic uv radiation. The technique permits irradiation either of all the nucleus or of all the cytoplasm with little overlap. Whole-cell irradiations were also performed, both with the microbeam and with the germicidal lamp, and photoreactivation was investigated. Interactions between the effects of uv damage on the nucleus and cytoplasm were small and possibly insignificant. This does not mean that one organelle does not possess recovery potential for the other, but merely that such factors, if they exist, are not uv-radiosensitive. In flattened cells, for a standard division delay (doubling of time to complete the second division after irradiation), nuclear irradiation required six times as large a dose (ergs/mm^2) as cytoplasmic irradiation; for killing (lysis within 3 weeks), nuclear irradiation required about the same dose as cytoplasmic irradiation. From this behavior and the lack of interactions noted above, it was concluded that killing of a flattened A. proteus with uv results about equally from damage to the nucleus and to the cytoplasm, whereas division delay results almost entirely from cytoplasmic damage. When a free (unflattened) amoeba is irradiated with uv below 300 mμ, the effects appear to be due almost solely to cytoplasmic damage, owing to shielding of the nucleus by overlying cytoplasm. A. proteus shows a small but significant photoreactivation of both division delay and killing after nuclear irradiation, but a much larger photoreactivation of both effects after cytoplasmic irradiation (photoreactivable sectors of 0.45 for killing and 0.6 for division delay). This appears to be the first clear-cut demonstration of cytoplasmic photoreactivation in a whole cell. In general, these experiments confirm the suggestion by others that the amoeba cytoplasm plays an important role in radiation response. The present experiments have eliminated the possibility that this unusual response is due only to shielding of the nucleus by the cytoplasm. They have also shown that the principal site of damage in the cytoplasm is apparently nucleic acid, since this damage is highly photoreactivable. (auth)

9919 RADIATION-INDUCED LIFE-SHORTENING IN DROSOPHILA. Lamb, Marion J. (Birkbeck Coll., London); Smith, J. Maynard. Radiat. Res.; 40: 450-64(Nov 1969).

Data are presented showing that the reduction in life span of male Drosophila melanogaster produced by a given dose of radiation is smaller for doses given later in life. This suggests the hypothesis that radiation shortens life by accelerating subsequent ageing, so that the reduction in life span for small doses is proportional to the dose and to the expectation of life prior to the dose being given. It is shown that this hypothesis can explain our own data on delayed doses, and can also explain the data of Baxter and Blair (1967, Radiation Res. 30, 48-70, and 31, 287-303) on life span after varying doses given to young flies and on divided doses. There is, therefore, no need to suppose that there is a component of the damage which is proportional to the square of the dose, or that there is a threshold dose below which radiation has no life-shortening effect. (auth)

9920 STUDIES OF SPERM TRANSFER, SPERM STORAGE, SPERM MOTILITY, AND EARLY MATING IN DROSOPHILA. Fowler, Gregory Lynn. Providence, Brown Univ., 1968. 71p. Thesis.

Oregon-R (wild type) males approximately 24 hours old were irradiated with varying doses of x rays and the effect on the transfer of sperm determined. Data support the suggestion of Yankers (1964) that the mean number of sperm delivered to the female is inversely proportional to the dose of x irradiation. The technique used in the present experiments, however, provides information on two points not possible to obtain by the method employed by Yanders: the determination of number of sperm transferred at the various doses of x irradiation and sperm transfer by males that were actually observed to mate thereby providing a means of distinguishing between those males that failed to copulate and those that failed to transfer sperm after copulation; Males heterozygous for the second chromosome markers Segregation-Distorter (SD) and cn bw were used in experiments dealing with the storage of low numbers of sperm in the female. There was evidence that distribution of sperm in the ventral receptable and the spermathecae are related to the size of the ejaculate. Estimates were made of the motility of sperm in the seminal vesicle in Oregon-R males dissected at various times following x irradiation and compared with the number of sperm transferred by x-ray treated sibs. It was suggested that loss of motility cannot be solely responsible for the reduction in the transfer of sperm following x irradiation, a possibility suggested by Yanders (1964). The possible role of other factors in the sperm transfer process is discussed in relation to this finding. In addition to studies of sperm storage and sperm transfer, the results of experiments dealing with a case of early mating in Drosophila melanogaster males established that approximately 50% of a population of SD/cn bw males mate earlier (7-12 hours following eclosion) than do Oregon-R males who do not reach the same level of sexual activity until 18-24 hours after eclosion. (TSS) (Diss. Abstr.)

Vertebrates

Refer also to abstracts 9742, 9752, 9754-9763, 9766, 9770, 9772, 9774, 9776, 9777, 9782, 9784-9787, 9789, 9792, 9806, 9810, 9815, 9874-9876, 9879, 9880, and 9881.

9921 (AEC-tr-7026) RADIOBIOLOGY. Translation of Radiobiologiya; 9: No. 3, 339-480(1969). 214p. Dep. CFSTI.

Abstracts of articles within the scope of NSA were prepared from the original language and appeared in previous issues of this journal. (H.G.D.)

9922 (CONF-690303-, pp 231-53) EFFECTS OF SINGLE OR FRACTIONATED X IRRADIATION AND OF BONE-SEEKING RADIONUCLIDES ON MAMMALS: A REVIEW. Bustad, Leo K. (California Univ., Davis. Radiobiology Lab.).

In 1951 an experiment was begun to determine the late effects of single or fractionated whole-body x irradiation of young adult beagle dogs at the University of California, Davis. Reproductive capacity, based on the number of pups weaned in two successive litters, was utilized as a quantifiable means of measuring radiation effect. No decrement in reproduction was observed as a result of 100 R or 300 R x irradiation, even though the latter dose was acutely lethal to some dogs. All irradiated beagles exhibited life-span shortening, relative to controls, of about 9% for 100 R and 20% for 300 R, an equivalent of about 6%/100 R. Median survival time increased, however, in proportion to the length of the interval between fractionated x-ray exposures totaling 300 R. In 1958 studies were begun on the toxicity of ^{90}Sr fed to beagles daily from midgestation to young adulthood. At the same time, comparable groups of dogs were injected with ^{226}Ra. Following the labeling period, skeletal ^{90}Sr deposition was reduced more rapidly in trabecular bone (half-time <1 yr) than in cortical bone (half-time about 15 yr). Almost none of the ^{90}Sr in teeth was lost. The average skeletal dose rate was about 6 rads per day at the highest

feeding level; the mean marrow dose was 0.5 to 0.8 of bone dose. Although the radiation dose to bone marrow was less than that to bone, the earliest change noted was in the leukocytes. Neutrophils showed the greatest response, almost 50% reduction by 18 months of age in the highest level group. The lymphocytes showed about 30% reduction in the same group. Although the erythrocyte and neutrophil precursors were apparently exposed to comparable radiation doses, peripheral erythrocyte numbers and packed cell volumes appeared unaffected except in animals that developed myeloproliferative disease. This disease involved at least 14 dogs in the two highest ^{90}Sr groups and none in the ^{226}Ra groups. It presents a morphologic spectrum extending from myelofibrosis with myeloid metaplasia to granulocytic leukemia. Long bones from dogs that received ^{90}Sr from early gestation had flintlike shafts that resisted breaking, narrowed marrow cavities, and thickened cortices. Radiation during development apparently depressed the remodeling process, affecting osteoclastic activity more than osteoblastic activity. The increase in hardness and thickness was not detected radiographically. In fact, even at the highest feeding levels, ^{90}Sr changes to date are limited to endosteal and periosteal thickening. In contrast, extensive bone changes, including spontaneous fractures and osteogenic sarcoma, are observed at the highest levels of ^{226}Ra. The application of positron camera scanning is valuable in studies of bone-blood flow and erythropoietic acitivity; work in this area is continuing. Other continuing studies include evaluation of natural and radioinduced aging effects and utilization of the marsupial Marmosa mitis in cytogenetic and immunologic investigations of radiation damage. (auth)

9923 (CONF-690303–, pp 269-81) LATE EFFECTS OF EXTERNAL IRRADIATIONS IN ANIMALS AND THE PREDICTION OF LOW-DOSE EFFECTS. Grahn, Douglas (Argonne National Lab., Ill.).

The late effects of whole-body exposure to ionizing radiation are well defined in terms of life shortening in experimental animals. In mice, for example, single exposures will produce a life shortening of 28 days/100 R, whereas lifetime exposures at dose rates below 25 R/day will induce only a loss of 4 days/100 R accumulated. Life-table statistics offer a sensitive approach to such data and also provide a rational basis for interspecies extrapolation. Present data would suggest that man would incur a loss of 1 day/R for low-dose-rate protracted exposures and 5 to 10 days/R for brief high-dose-rate exposures. Tumor death rates are less well developed in mice, though they are precise for man. Induction probabilities appear to be about 10^{-6} per rad per man-year at risk for leukemia, thyroid, and bone cancers. Estimation of exact risk at extremely low doses remains obscure owing to the interaction of biological and environmental factors. (auth)

9924 (CONF-690303–, pp 319-25) RADIATION AND VIRUS INTERACTIONS IN LEUKEMOGENESIS. Kaplan, Henry S. (Stanford Univ., Calif. Dept. of Radiology).

The C57 BL strain of mice exhibited a very low spontaneous incidence of leukemia, but were extremely susceptible to the induction of lymphatic leukemia by exposure to x rays. It was shown that irradiation of both the thymus and the bone marrow were essential and that protection against leukemia was afforded by shielding the spleen or the bone marrow of the legs or by injecting the irradiated animals with marrow cells from nonirradiated mice. The most conclusive evidence against somatic mutation was that susceptibility to leukemia in thymectomized irradiated mice was partially restored by the subcutaneous implantation of isologous thymus grafts. Evidence indicated that the virus is the actual causative agent and that radiation acts primarily to alter the host-virus relation, with the result that the probability of virus-target cell interaction leading to neoplasia is greatly increased. (H.L.W.)

9925 (ORO-3554-2) QUANTITATIVE STUDIES OF RADIATION EFFECTS ON THE INCISOR TEETH OF RATS. Progress Report (Final), February 28, 1967–December 31, 1968. Willhoit, Donald G. (North Carolina Univ., Chapel Hill. Dept. of Environmental Sciences and Engineering). Jan. 1969. Contract AT-(40-1)-3554. 11p. Dep. CFSTI.

The migration rate of amelogenic cells of rat incisor teeth was measured by autoradiographic techniques and found to be about 480 microns per day. The length of the differentiation zone is about 950 microns, indicating a maturation time of approximately 48 hours. The length of the differentiation zone decreased following x ray exposure suggesting that differentiation continues even though the proliferative compartment is blocked and not supplying new cells to the differentiating compartment. The length of the differentiation zone was still less than the normal 12 days post-exposure, indicating that recovery was incomplete at that time. (auth)

9926 REACTIVE CHANGES IN THE RAT ADRENAL CORTEX UNDER CONDITIONS OF INTERNAL IRRADIATION. Truupyl'd, A. Yu.; Tokin, I. B. (Scientific Research Inst. of Radiation Hygiene, Leningrad). Radiobiologiya; 9: 393-8 (1969). (In Russian).

In the early period after the administration of ^{144}Ce, ^{137}Cs, and ^{90}Sr, there is a nonspecific reorganization of the organ and a direct radiation damage to its cells. The earliest and most pronounced changes in the adrenal cortex (functional, alternative, proliferative) are noted after the incorporation of ^{137}Cs. The reactive changes in the cortex after the incorporation of ^{144}Ce are qualitatively similar to those after the administration of ^{137}Cs, but are characterized by greater duration. Radiation damage to the adrenal tissue by ^{90}Sr is negligible. (tr-auth)

9927 STATE OF THE NEUROSECRETORY SYSTEM OF THE HYPOTHALAMUS DURING RADIATION SICKNESS IN DOGS. Bibikova, A. F.; Izmailova, G. M. (Inst. of Biophysics, Moscow). Radiobiologiya; 9: 407-10(1969). (In Russian).

The dynamics of the change in the state of the neurosecretory nuclei of the anterior hypothalamus of dogs irradiated at a dose of 350 R were studied. One to three days after irradiation, hypersecretion and an intensification of the discharge of neurosecretion are noted. In the stage of pronounced clinical manifestations of acute radiation sickness, a gradual exhaustion of the neurosecretory function of the cells is observed, which is accompanied by dystrophic and necrobiotic changes in the neurons and vessels of the hypothalamic region. (tr-auth)

9928 INFLUENCE OF IONIZING RADIATION ON THE DENDRITIC POTENTIALS. Cherkasov, V. F.; Nesterenko, V. S.; Kudryavtsev, V. D. (Inst. of Medical Radiology, Obninsk, USSR). Radiobiologiya; 9: 447-50(1969). (In Russian).

The changes in the functions of the axodendritic synapses of the first layer of the cortex in response to direct stimulation of its surface at various periods after irradiation were studied. In rats after irradiation at a dose of 800 R, a substantial change in the amplitude, duration, and thresholds of appearance of the dendritic potentials was observed during the entire observation period. The data obtained indicate a complex nature of the functional changes arising in the axodendritic synapses of the first cortical layer after irradiation. (tr-auth)

9929 INFLUENCE OF WHOLE-BODY X-IRRADIATION ON THE MIGRATION OF BONE MARROW CELLS AFTER THEIR SUBCUTANEOUS INJECTION. Revis, V. A. (Kalinin Medical Inst., USSR). Radiobiologiya; 9: 439-41(1969). (In Russian).

It was shown by the method of histoautoradiography and cytological labeling that in the case of subcutaneous injection of bone marrow cells labeled with thymidine-^{3}H, their distribution is not the same in healthy rabbits and rabbits irradiated at a dose of 1100 R. Among the intact animals, the labeled cells do not penetrate into the circulatory system of the recipient. Among the irradiated animals, donor cells are briefly (two to four days after transplantation) detected in negligible numbers in the circulatory system of the recipient. (tr-auth)

9930 PARALLELS BETWEEN THE INCORPORATION OF ^{144}Ce AND ITS BIOLOGICAL ACTION. Tokin, I. B.; Ponomareva, T. V.; Merkushev, G. N.; Syromyatnikov, Yu. E. (Scientific Research Inst. of Radiation Hygiene, Leningrad). Radiobiologiya; 9: 454-6(1969). (In Russian).

The morphological changes induced by the action of incorporated cerium-144, injected intraperitoneally in amounts of 2.10^{-4} Ci per rat, and the data of a radiometric investigation of certain organs were compared. The presence of a correlation between the degree of morphological changes in the intestines, lymph nodes, adrenals, and the percent content of the isotopes in these organs was shown. In the liver destructive changes are detected at later periods, being intensified parallel with an increase in the integral absorbed dose. (tr-auth)

9931 COMPARATIVE STUDY OF THE EFFECTS OF CERTAIN RADIOACTIVE ISOTOPES ON THE EPITHELIUM OF THE RAT DUODENUM. Ponomareva, T. V.; Tokin, N. B. (Scientific Research Inst. of Radiation Hygiene, Leningrad). Radiobiologiya; 9: 452-4(1969). (In Russian).

The communication presents the results of an investigation of the effects of a number of incorporated isotopes on the intestinal epithelium (the mitotic activity, number of chromosome aberrations, and level of the cell population were analyzed). The dynamics of the change in these indexes depends on the dose rates in the intestines. (tr-auth)

9932 CHANGES IN HEMATOPOIESIS AND WEIGHT LOSS OF RAT TESTES UNDER VARIOUS CONDITIONS OF NON-

UNIFORM X-IRRADIATION. Avetisov, G. M. (Inst. of Biophysics, Moscow). Radiobiologiya; 9: 367-72(1969). (In Russian).

In experiments on 200 male rats, irradiated at doses $LD_{50/30}$ equally effective with respect to death rate, in fields of x-irradiation differing in nonuniformity, the dynamics of various indices of hemopoiesis and the change in the weight of the testes were studied, and the data obtained were compared with the doses and other dosimetric characteristics in various organs of the animal. (trauth)

9933 SURVIVAL OF HIBERNATING GROUND SQUIRRELS (CITELLUS TRIDECEMLINEATUS) AFTER SINGLE AND FRACTIONATED DOSES OF ^{60}Co GAMMA RADIATION. Jaroslow, Bernard N.; Smith, Douglas E.; Williams, Marilyn; Tyler, Sylvanus A. (Argonne National Lab., Ill.). Radiat. Res.; 38: 379-88(May 1969).

The effects of hibernation on survival after irradiation was studied in thirteen-lined ground squirrels (Citellus tridecemlineatus). The $LD_{50(30)}$ for a single dose of ^{60}Co γ radiation was 1024 rads for ground squirrels irradiated and maintained at 23°C, whereas the $LD_{50(30)}$ was 1127 rads for ground squirrels irradiated during hibernation and subsequently maintained in the cold room at 5°C for three weeks before they were returned to 23°C. Survival was higher in ground squirrels aroused from hibernation 1 day after an exposure to 1160 rads (79%) than in ground squirrels aroused from hibernation 2 weeks after exposure to 1160 rads (37%). The squirrels that were given 1160 rads at 23°C and maintained at 23°C had 9% survival. When ground squirrels were given two doses of 668 rads, 6 hours apart, survival was greatest (73%) in the hibernating group that was kept in the cold room 3 days before, during the interval between, and for 20 hours after the second dose of gamma rays. The next highest survival (46%) was observed in the hibernating group that was treated the same, but was aroused immediately after the second dose of gamma rays. The hibernating groups that were aroused between the two exposures to radiation had no greater survival (29%) than the euthermic controls (29%). (auth)

9934 THE EFFECT OF BODY TEMPERATURE AND POSTIRRADIATION COLD EXPOSURE ON THE RADIATION RESPONSE OF THE HIBERNATOR CITELLUS TRIDECEMLINEATUS. Barr, R. E.; Musacchia, X. J. (Univ. of Missouri, Columbia). Radiat. Res.; 38: 437-48(May 1969).

The effects of exposing ground squirrels, Citellus tridecemlineatus, to ^{60}Co radiation while at body temperatures of 5°C, 13°C, 23°C, or 37°C and of maintaining groups of these squirrels in environments with temperatures 5°C, 13°C, and 23°C for up to 90 days have been studied. These studies were conducted in the form of three separate experiments. Results of experiment I indicated that squirrels irradiated while hibernating at 5°C and immediately placed in an environment of 23°C had higher percentages of survival than squirrels irradiated while active or while hibernating and maintained in a cold room at 5°C for 30 days. The percentage of survival was higher among squirrels in the latter groups than among squirrels irradiated while active. Results of experiment II showed that squirrels with body temperatures of 5°C, 13°C, 23°C, or 37°C at the time of irradiation exhibited marked differences in survival percentages at 180 days postirradiation. For example, squirrels receiving 1250 rads had survival percentages of 33%, 75%, 50%, and 0%, respectively. Experiment III indicated that a complicated relationship existed between the effects of a postirradiation exposure to environments of 5°C, 13°C, 23°C for 90 days and the effects of irradiating squirrels while at body temperatures of 5°C, 13°C, 23°C, or 37°C. Paramount in this relationship was a marked deleterious effect on survival among squirrels maintained in the 13°C environment. (auth)

9935 THE REGULATION OF CELL PROLIFERATION AND DIFFERENTIATION IN INTESTINAL EPITHELIUM. II. A QUANTITATIVE HISTOCHEMICAL AND AUTORADIOGRAPHIC STUDY AFTER LOW DOSES OF X-IRRADIATION. Galjaard, H.; Bootsma, D. (National Defence Research Organization, Rijswijk, Netherlands). Exp. Cell Res.; 58: No. 1, 79-92(Nov 1969).

To investigate the biochemical mechanisms involved in the regulation of cell proliferation and differentiation, the intestinal epithelium was chosen because of the regular distribution of proliferative-, non-dividing maturing-, and functional cells along the crypt and villus. The effect of low doses of x irradiation (50 to 400 R) that selectively influences the pool of proliferating cells was studied using quantitative histochemical techniques for enzyme assays in the cell compartments and ^{3}H-thymidine labeling with subsequent autoradiography to determine the localization of the proliferating cells and the migration rate of the cells along crypt and villus. In normal crypt and villus the activity of the group of non-specific esterases was the only group of enzymes tested of which the activity was different in the various cell compartments. Hardly any activity was present in the proliferating cells, a higher activity in the non-dividing maturing crypt cells, and a very high activity in the functional cells of the villus. After irradiation, the esterase activity in the crypt was markedly reduced and the duration of this effect and the number of crypt cells involved appeared to be clearly related to an increase in the pool of proliferating cells. While in the normal crypt, the proliferating cell makes a critical decision to enter the non-dividing maturing-cell compartment about halfway along the length of the crypt, during the period of recovery from irradiation the cell appears to be able to postpone this decision and many do not stop proliferation until the functional compartment of the villus is reached. The continuation of cell proliferation is always accompanied with a loss of esterase activity. As after irradiation the pool of proliferating cells has increased at the expense of the maturing cell compartment and the migration rate of the cells was not influenced, cells with reduced esterase activity will enter the functional compartment of the villus. Microchemical analyses of various parts of a single villus showed that no changes in enzyme activity occurred while the functional cells were moving upwards along the villus. Experimental results are discussed in relation to the problem of the critical decision phase in the crypt, the possible role of esterase activity as a marker for cell differentiation, and the functional implications of changes in the proliferative and maturing-cell compartments. (auth)

9936 ACUTE MORTALITY OF CHINCHILLAS EXPOSED TO MIXED GAMMA-NEUTRON RADIATIONS OR 250-kVp X-RAYS. Strike, Thomas A.; Seigneur, Leslie J. (Armed Forces Radiobiology Research Inst., Bethesda, Md.). Radiat. Res.; 38: 414-24(May 1969).

The chinchilla's acute mortality response to mixed gamma-neutron radiations of the AFRRI-TRIGA reactor and 250-kVp x rays was studied. Unilateral whole-body irradiations were accomplished at doses from 200 to 639 rads of mixed gamma-neutron radiations and from 357 to 1786 rads of x rays. All radiations were delivered at approximately 20 rads/min and reported as midline doses. The $LD_{50(30)}$ values calculated for the mixed gamma–neutron radiations and for the x rays were 295 rads and 490 rads, respectively. With 30-day median lethality as the end point, the RBE of the mixed gamma–neutron radiations was 1.7. The wide lethal dose range obtained was attributed to a high degree of variation in age and weight of the chinchillas. At the supralethal doses of radiation associated with the gastrointestinal mode of radiation death in mice and rats (3 to 5 days mean survival times), the mean survival times for the chinchillas ranged between 6.3 and 9.6 days. (auth)

9937 EFFECTS OF HEAD IRRADIATION ON PARADOXICAL SLEEP (EEG AFTERREACTION) IN THE RABBIT. Ono, Yoshimi; Tsuya, Akira; Kawakami, Masazumi (Yokohama Municipal Univ., Japan. Cancer Inst. Hospital, Tokyo). Radiat. Res.; 38: 365-78 (May 1969).

The effects of ^{60}Co γ radiation on the central nervous system were studied by electroencephalography on unrestrained and nonanesthetized adult rabbits with permanent electrodes implanted into the cortical area and several subcortical regions. The changes in threshold value of EEG afterreaction (EA) induced by low-frequency square waves, as well as the changes in the appearance of spontaneous EA, were examined. A single exposure of 20 or 50 R to the whole head resulted in a transient elevation in threshold value for three to nine hours, irrespective of the dose given. After an exposure of 100 R or more there was an almost linear relationship between the maximum threshold value and the given exposure, but the individual difference was noticeable at 100 R or less. Dose dependency was observed in the time for the elevated threshold value to recover completely. A transient disappearance and decrease in appearance time were observed in the spontaneous EA at exposures above 500 R, and a relative increase of the ratio of EEG spindle-burst stage to EA at exposures above 1000 R. (auth)

9938 POST-IRRADIATION PROPERTIES OF CULTURED CHINESE HAMSTER CELLS EXPOSED TO ULTRAVIOLET LIGHT. Todd, Paul; Coohill, Thomas P.; Hellewell, A. B.; Mahoney, Judith A. (Pennsylvania State Univ., University Park). Contracts NsG-324; AT(30-1)-3834. Radiat. Res.; 38: 321-39(May 1969).

Cultured Chinese hamster cells, line M3-1, were exposed to 2537 Å ultraviolet light. Postirradiation growth studies indicated that nonsurviving cells do not divide and that cells surviving a 95% lethal exposure resume growth at a normal rate after a 30-hour lag. Split-dose experiments, in which survival was evaluated on the basis of colony formation, indicated the surviving cells do not repair sublethal injury promptly, as with x irradiation, but acquire their original resistance after about 30 hours (in the case

of cells surviving a 95% lethal exposure). Some surviving cells developed into small colonies which, when selected and subcultured, were found to grow more slowly and to possess increased sensitivity to x-irradiation; these defective properties persisted for 10 to 20 weeks. (auth)

9939 ON THE PROBLEM OF STANDARDIZING PERIODIC MICROWAVE IRRADIATION. Lobanova, E. A. Gig. Tr. Prof. Zabol.; 12: 23-7(Nov 1968). (In Russian).

Results are reported from an investigation into the biological effects of intermittent and constant microwave (in the 10 cm band) irradiation in acute and chronic tests. A study of survival of albino mice demonstrated the biological activity of intermittent irradiation to be inferior to the constant one. Analogous results were obtained when inquiring into the conditioned-reflex activity of rats undergoing intermittent and constant irradiation over equal lengths of time (the amount of the acting energy in intermittent irradiation being lower). Under experimental conditions ensuring the equality of the applied amounts of the energy intermittent irradiation produced initially (for a period of 2½ months) more pronounced changes, while at later dates the effects of exposure to intermittent and constant irradiation proved the same. (auth)

9940 PROLONGATION OF LIFE: ROLE OF FREE RADICAL REACTIONS IN AGING. Harman, Denham (Univ. of Nebraska, Omaha). J. Amer. Geriat. Soc.; 17: 721-35(Aug 1969).

The relations between free-radical reactions, the adverse effects of whole-body ionizing radiation, radiation resistance, and the mean normal longevity of different strains of mice were discussed. Strains of mice with the highest radiation resistance possessed the longest normal life span. The strain-specific factors protected against the radiation-derived radicals and the endogenously formed radiation-derived radicals and the endogenously formed radicals. This expectation was realized in the observation that radiation resistence for mice rose linearly with their median life span. The chemical aspects of free-radical reactions were discussed. The deleterious effects of free radicals included accumulative oxidative alterations in the long-lived molecules of collagen, elastin, and chromosomal material; breakdown of mucopolysaccharides through oxidative degradation; accumulation of metabolically inert material such as ceroid and age pigment through oxidative-polymerization reactions involving lipids, particularly polyunsaturated lipids, and proteins; changes in membrane characteristics of such cytoplasmic elements as mitochondria and lysosomes, due to lipid peroxidation; and arteriolocapillary fibrosis due to peroxidation products of serum and vessel-wall components, probably chiefly lipids, acting as vessel-wall irritants. The rate of free-radical reactions and their inhibition by compounds such as 2-mercaptoethylamine and butylated hydroxytoluene were discussed. Thus far, efforts to minimize random free-radical reactions in animals have resulted in significant increases in the mean life span but little, if any, increases in the maximum life span. The addition of inhibitors of free-radical reactions to nutritionally adequate and acceptable natural diets selected to minimize the intake of substances that might participate in endogenous free radical reactions was discussed. (BBB)

9941 RADIOBIOLOGICAL INVESTIGATIONS ON EMBRYONIC RAT BONE GROWN IN VITRO. Mawhinney, B. S.; Kember, N. F. (Royal Free Hospital School of Medicine, London). Radiat. Res.; 40: 385-99(Nov 1969).

An organ culture system has been used to study the effect of x rays on embryonic rat tibiae. The effect of the irradiation was to decrease the elongation and wet weight of tibiae which were cultured for 8 days. This effect increased with dose in the range 0 to 1000 rad, and 800 and 1000 rad also caused attenuation of the epiphyses and diaphysis. Fractionation of the dose caused little effect in vitro but when the irradiation was in vivo there was a marked recovery and this was greater with increased fractionation time and low doses. Irradiation under N_2 had a protective effect on the explants and irradiation under O_2 a sensitizing effect. Possible mechanisms of damage are discussed. (auth)

9942 LEYDIG-CELL TUMORS IN RAT TESTES SUBJECTED TO LOW-DOSE X-IRRADIATION. Lindsay, Stuart; Nichols, Clarence W. Jr.; Sheline, Glenn E.; Chaikoff, I. L. (Univ. of California, San Francisco. Univ. of California, Berkeley). Contract AT(11-)-34. Radiat. Res.; 40: 366-78(Nov 1969).

Interstitial cell (Leydig) tumors of the testes were found in rats 2 years after they had been subjected to localized testicular irradiation. While only one neoplasm appeared in 45 nonirradiated control rats, 6 of 62 rats irradiated with 150 R, and 40 of 74 rats irradiated with 500 R had interstitial cell neoplasms. All the neoplasms were benign and confined to the testes, and none metastasized. Apparently these neoplasms developed from hyperplastic interstitial cells, and gonadotropin stimulation is suggested as a promoting factor in their pathogenesis. (auth)

9943 A STAINING TECHNIQUE FOR SPLEEN NODULES. A COMPARISON OF D_0's. Larsen, R. M.; Ainsworth, E. J. (Naval Radiological Defense Lab., San Francisco). Radiat. Res.; 40: 379-84(Nov 1969).

The colony-forming unit (CFU) is thought to be a (the) hematopoietic stem cell, and CFU methodology has been used extensively to evaluate radiation damage to the hematopoietic system in mice. Although the method works quite satisfactorily, the counting of macroscopic spleen nodules is laborious, time-consuming, and, to a certain extent, subjective. A staining-clearing method has been developed which greatly facilitates and renders this method less tedious and more reproducible. The spleen nodules appear as blue-green spheres in a nearly colorless spleen parenchyma. Estimates of radiation sensitivity (D_0) of CFU are not altered by the use of the staining-clearing procedure. However, estimates of the CFU count/10^5 nucleated marrow cells, or CFU content/femur, are reduced when the staining technique is used. (auth)

9944 GROWTH IN PRENATALLY IRRADIATED RATS AS INDICATED BY CHANGES IN CELL NUMBER AND CELLULAR MATERIALS. Martin, Polly G.; Murphree, R. L. (Univ. of Tennessee, Oak Ridge). Contract AT-40-1-GEN-242. Radiat. Res.; 40: 330-40(Nov 1969).

Growth in rats exposed to 220 R of ^{60}Co γ-radiation on Day 18 of gestation was determined by measuring changes in body and organ weights, total DNA (cell numbers), protein and RNA content of four organs. Average weights of irradiated animals (male and female) ranged from 78 to 84% of controls at birth to 51% of controls at Day 30. Average weight of irradiated rats was 75% of controls at Day 365. Differences in weights with respect to controls of the four organs, liver, kidney, spleen and thymus, were due to significantly less ($P < 0.05$) DNA (cells) in the irradiated animals. At Day 160, DNA (cells) for the liver of the irradiated males were not significantly different (86%) from controls. Decreases in protein and RNA content of the irradiated organs coincided with periods of mitosis. Growth due to the increased accumulation of cells was extended to at least 60 days postnatally in the irradiated animals for both sexes. Organ weights of irradiated animals when expressed as percentage of body weight were similar to controls at almost every age studied except Day 30. Possible reasons for a shift in the growth pattern and growth retardation in irradiated animals are discussed. (auth)

9945 COMPARISON OF RADIATION SENSITIVITY, ENDOGENOUS COLONY FORMATION, AND ERYTHROPOIETIN RESPONSE FOLLOWING PROLONGED HYPOXIA EXPOSURE. Okunewick, J. P.; Hartley, K. M.; Darden, J. (National Naval Medical Center, Bethesda, Md.). Radiat. Res.; 38: 530-43 (Jun 1969).

Experiments were carried out to evaluate the effect of continual hypoxia exposure on the hematopoietic system of mice. Three parameters have been investigated: Sensitivity to x irradiation at exposure levels between 675 and 775 R; formation of endogenous erythroid colonies in the spleen after x irradiation; and response to erythropoietin injection. The results indicate that sensitivity to x irradiation is lessened, colony formation is greater, and erythropoietin response is enhanced when these tests are performed 3 days after cessation of hypoxia on mice previously exposed for 3 to 4 weeks to air at one-half atmosphere of pressure. The findings suggest that prolonged stimulation of the erythroid system results in an enlargement of those hematopoietic compartments associated with reproduction and with response to erythropoietic stimulation. (auth)

9946 EFFECTS OF HIGH-DOSE X-IRRADIATION ON OLFACTION IN ANESTHETIZED RABBITS. Cooper, G. P. (Univ. of Cincinnati). Contract AT(11-1)-1669. Radiat. Res.; 38: 544-50(Jun 1969). (COO-1669-5).

Responses of the olfactory system to strong odor stimulation were studied in anesthetized rabbits immediately after x irradiation (250 kVp) of the head. The sinusoidal potentials (induced waves) recorded from the surface of the olfactory bulb during odor stimulation were abolished by surface doses of 50 to 70 kR during periods of irradiation of 2 to 4 hours. Slightly higher doses were required to abolish immediately all neuronal response to odor, as determined by microelectrode recordings of single olfactory bulb neurons. Response failure was due primarily, if not entirely, to effects of radiation on the olfactory bulb, since olfactory receptor responses to odor were readily obtained after abolition of all responses in the olfactory bulb. (auth)

9947 CONCENTRATION OF SERUM ALBUMIN IN VASCULAR AND EXTRAVASCULAR TISSUE POOLS OF THE MOUSE AFTER X-IRRADIATION. Sassen, A.; Rueter, A. M.; Kennes, F. (Nuclear Energy Study Center, Mol, Belg.). Radiat. Res.; 38: 475-82(Jun 1969).

Measurements of vascular volumes in plasma and tissues with

^{125}I-labeled fibrinogen and of tissue albumin concentration by radial immunodiffusion were used to calculate the vascular and extravascular albumin pools of eight tissues. Modifications of these pools were studied in mice exposed to 800 R of x irradiation. Extravascular albumin was found to decrease before and to a greater extent than albumin in circulation. Nine days after irradiation, the loss amounted to 40% of the total body pool. (auth)

9948 AGE AT X-IRRADIATION AND ACUTE RADIATION MORTALITY IN THE ADULT MALE RAT. Jones, D. C.; Osborn, G. K.; Kimeldorf, D. J. (Naval Radiological Defense Lab., San Francisco). Radiat. Res.; 38: 614-21(Jun 1969).

Male rats received whole-body single doses of 250 kVp x rays at various ages ranging from young adulthood to old age. From probit analysis, the $LD_{50(30)}$ values for groups exposed at 3 or 7 months of age were 851 and 900 R, respectively. After adjustment for the natural mortality rate, $LD_{50(30)}$ values for groups exposed at 17, 21, or 24 months of age were 776, 806, and 747 R, respectively. The mean survival time at the $LD_{50(30)}$ for the group exposed at 3 months of age exceeded those for groups irradiated at older ages. The slope of the dose versus survival curve for the youngest group was almost twice that for groups exposed at older ages, reflecting increased variability of the population at older ages. These findings indicate that age at exposure is an important variable to be considered in establishing parameters of acute radiation mortality in adult animals. (auth)

9949 RADIOSENSITIVITY AND FRACTIONATION RESPONSE OF CRYPT CELLS OF MOUSE JEJUNUM. Withers, H. R.; Elkind, M. M. (National Cancer Inst., Bethesda, Md.). Radiat. Res.; 38: 598-613(Jun 1969).

The dose survival and regeneration characteristics of x-irradiated jejunal crypt stem cells were studied in the mouse by using a cell-cloning technique. An outstanding characteristic which was observed is that crypt cells have a large capacity for sublethal injury and its repair. It is diffucult to separate the contributions of sublethal injury repair, division cycle synchrony, and cell proliferation to the increased survival measured in two-dose experiments, but we have estimated that, of an overall recovery ratio of about 70 in 24 hours, about a factor of 50 may result from repair of sublethal injury. The single-dose survival curve measured in oxygen is described by a $\bar{D}_0$ value of 97 rads. A second-dose survival curve measured 24 hours after an initial dose of 660 rads is roughly parallel to the single-dose curve, but at shorter fractionation intervals the slope may vary. Changes in the shoulder and slope of second-dose survival curves cause a fluctuating pattern in the recovery curve for at least the first 15 hours postirradiation. The time at which survivors of a dose of 660 rads resume cell division is not clear, but at about $2\frac{1}{2}$ days after a first dose, the loss of progeny through terminal differentiation probably stops, resulting in a rapid expansion of cells in proliferation. This leads to a relatively early overshoot in the size of the proliferative population, compared to its size before irradiation, followed by a return to a normal level and a resumption of steady-state kinetics within about 1 week postirradiation. Good agreement was found in a comparison of recovery occurring between two dose fractions using two different end points: 50% survival of animals from abdominal irradiation, and crypt stem cell survival. The number of crypt stem cells surviving a dose lethal to 50% of the animals within 5 days is about 10,000 per centimeter of jejunum regardless of fractionation schedule. (auth)

9950 RADIATION AND CANINE VISUAL LEARNING. Henke, Allen Harold. Fort Collins, Colo.; Colorado State Univ. (1968). 142p.

Thesis.

The purpose of the present study was to investigate the effects of two levels of radiation exposure on the visual discrimination performance of the Beagle dog. The two levels of irradiation were zero and 325 R given at two days post-natal or 65 days post-breeding, whichever was longer. A training problem, consisting of a vertical striped card and a horizontal striped card, and one of three test problems were employed for each animal. A modified Wisconsin General Test Apparatus (WGTA) was used to present the stimuli to the animals. Each animal received the same training problem with the exception that for one-half the animals, horizontal was correct; whereas for the other one-half of the animals vertical was correct. Following the training problem; the animals were randomly assigned to one of three test problem groups within one of the two radiation groups. Errors and response latencies were recorded. All animals received 40 trials per day and were run five days per week. An analysis of response latencies yielded a difference between irradiation groups with the irradiated animals taking longer to respond than the controls. Pronounced position habits were found for both irradiation groups with 30 out of 36 animals demonstrating this phenomenon. (TSS) (Diss. Abstr.)

9951 EFFECTS OF X-RADIATION ON MOUSE FETUS DURING GESTATION: EMPHASIS ON DISTRIBUTION OF CEREBRAL LESIONS. PART II. Dekaban, Anatole S. (National Inst. of Health, Bethesda, Md.). J. Nucl. Med.; 10: 68-77(Feb 1969).

A total of 152 female mice were irradiated on consecutive days of pregnancy between the 7th and 18th gestational day (g.d.). This resulted in 876 irradiated newborns. Exposure to irradiation on the 7th and 8th g.d. led to death and absorption of the majority of the fetuses; however, those which survived were largely normal at birth and only a small proportion had organ-type brain abnormality. Irradiation on 9 g.d. produced an increased number of cerebral abnormalities which included dysraphism, hydrocephalus, microencephaly and arrhinencephaly. Following irradiation between 10 and 12 g.d. entirely different cerebral lesions were found to occur; they included heterotopias, deformities of various structures, cellular deficiency and compensatory dilatation of the ventricles. From the 13th g.d. onward these lesions became smaller and less frequent, and after the 15th g.d. only mild architectonic imperfections were present. The heterotopias were most prominent in the subependymal region when irradiation occurred on the 10th and 11th g.d., in the white matter after exposure on the 12th g.d. and in the cerebral cortex following irradiation on the 13th and 14th g.d. Different functional regions (subdivisions) of the brain showed a varied degree of sensitivity to irradiation in general and especially in different gestational stages. Diencephalon olfactory system and a part of the limbic system had a low sensitivity in the range of irradiation used; the hippocampus and basal ganglia were moderately sensitive between 10 and 12 g.d. The neopallium and mesocortex were the most sensitive structures and severe damage was caused by irradiation between 10 and 13 g.d. while milder abnormalities occurred after exposure between 14 and 16 g.d. Most of the mice with cerebral lesions had small heads and their bodies were stunted. Tentative correlation of the stages of brain development in the mouse and man has been offered. Also a prediction of the type of cerebral lesions that may result from irradiation of the human fetus at various stages of pregnancy is suggested. (auth)

9952 STUDIES ON THE IRRADIATION EFFECTS ON NORMAL ORGANS. 1. THE INFLUENCES OF γ-RAY IRRADIATION ON THE RENAL FUNCTION IN RABBIT. Fujiwara, Kazunori (Tokushima Univ., Japan). Nippon Igaku Hoshasen Gakkai Zasshi, 29: 460-7(July 1969). (In Japanese).

Effects of radiation on renal function in rabbits were investigated by intravenous pyelography with respect to successive changes of excretory function after a single exposure and the effects of time factors for these changes. Doses of 300, 500, 1000 rads in a single exposure (tissue dose, 50 R/min) were applied to the life kidney of animals and pyelographic examinations were made before the irradiation as well as at periods of 30 min, 1, 3, 5, 7 days after the irradiation. It was shown that depressed renal function in rabbits resulted from local irradiations at a dose level of 300 rads, and it was proportional to dose applied. Two groups of animals were irradiated 300 rads, one group by 5 R/min, another by 30 R/min. To examine the effects of fractionation, 1200 rads were administered in 6 and 12 fractions in 14 days. Pyelographic examinations were made at periods of 1, 2, 3, 4 weeks after the beginning of irradiation. It was suggested that, as to the dose rate, when a certain dose is given in a single exposure at a high dosage rate, it produced a greater effect than the dose given at a low dosage rate, and when over-all time and the total dose were constant, the more the fractionation numbers were, the smaller the renal changes were. (TSS) (NSA of Japan)

Man

Refer also to abstracts 9545, 9738, 9801, 9833, 9836, 9883, 9903, and 9908.

9953 INFLAMMATORY COLON STENOSES: CONTINUED. Dietz, M. Wendell (Univ. of Missouri, Columbia). Missouri Med., 66: 358-61(May 1969).

A case history illustrating radioinduced intestinal stenosis is described along with 3 additional varieties of inflammatory stenosis of the colon. The postirradiation stricture occurred in an 80-yr-old woman who was hospitalized because of progressively severe constipation, abdominal distension with cramping pain, and decreased size of stools. Fifteen years earlier she had undergone 2 Ra applications and a course of external radiotherapy for carcinoma of the uterine cervix. Barium enema study revealed a lengthy nondistensible constriction of the midsigmoid colon. The narrowing caused proximal colon dilatation with fecal stasis. Unlike a primary carcinoma with abrupt transition to normal bowel, the edges of this stenosis were gradually tapered. Also, the length of the involved segment exceeded the usual dimensions of colon

adenocarcinoma. Haustra and mucosal forms were obliterated within the fixed tubular constriction. No intraluminal defect was observed. Operation revealed that the injured intestine was thickened and fibrotic, resembling a rubber hose. Numerous adhesions were present; the sigmoid was firmly adherent to the posterior uterine wall. Excision of the stenotic lesion resulted in prompt disappearance of symptoms. Features of this case which typify actinic colitis are discussed. (BBB)

9954 BEHAVIOR OF THE CARDIOVASCULAR SYSTEM DURING RADIUM THERAPY OF GENITAL NEOPLASMS. Brina, A.; Lo Cicero, G. (Univ., Milan). Ann. Ostet. Ginecol., 90: 825-42(Dec. 1968). (In Italian).

The behavior of the cardiovascular system in 82 patients undergoing radium therapy for neoplasms of the genital organs was examined. A complex of symptoms and of electrocardiographic modifications during and immediately after such treatment was seen. As a result it was stated that radium therapy may cause imbalance of the cardiovascular system although the aetiopathogenetic basis was not defined. The most serious complications (three fatal cases) were of a thrombo-embolic nature, so suitable prophylaxis was recommended. (auth)

9955 THERAPEUTIC IRRADIATION OF THE CHEST AND ELECTROCARDIOGRAPHIC CHANGES. Biran, S.; Hochmann, A.; Stern, S. (University Hospital, Jerusalem. Hebrew Univ., Jerusalem). Clin. Radiol.; 20: 433-9(Oct 1969).

The effect on the heart of therapeutic irradiation to the chest was evaluated. The electrocardiogram was studied regularly in a series of 75 patients following the radiation exposure for up to 3 years. Fifty of the patients had suffered from carcinoma of the left, and 25 patients from carcinoma of the right breast. All patients had had a normal control ECG before therapy. Four of the patients who received left chest irradiation and one patient who received right chest irradiation, developed permanent ECG abnormalities, detected during the first six months after the irradiation. The possible reasons for the relatively low incidence of ECG abnormalities following chest irradiation are discussed. (auth)

9956 CLINICAL PROBLEMS IN RADIATION HEMATOLOGY. Bauer, Robert. Aerztl. Forsch.; 23: 139-46(10 Apr 1969). (In German).

There are numerous questions to be solved in radiation hematology. Some of the clinically important problems are discussed including the hematological aspects of radiation-sickness; radiation therapy of myelosis; and chronic exposure to radiation, especially occupational exposure. Reactions in Thorotrast-treated patients, diseases of the blood caused by radiation, especially leukemia, and initial signs of radiation injuries of the blood are considered. The review intends to initiate further investigations in the field of radiation hematology. (auth)

9957 FATAL GASTROINTESTINAL COMPLICATIONS FOLLOWING COBALT THERAPY FOR CARCINOMA OF THE UTERINE CERVIX. Roscher, A. A. (Univ. of California, Irvine); Woodard, John S. Int. Surg.; 51: 526-36(Jun 1969).

The case history is presented for microinvasive carcinoma of the uterine cervix, treated with a combination of surgery followed by a full course of tumor dose ^{60}Co γ irradiation. The postirradiation complications, the difference of individual susceptibility, as well as the strict indication for irradiation are stressed. The course of events strongly suggests that in cases of in situ carcinoma of the uterine cervix, even with microinvasion, surgery alone would be more beneficial to the patient than a combination of surgery and irradiation, since such treatment seems to have much greater morbidity and mortality than surgery alone. On the other hand, in cases of advanced carcinoma of the pelvic region, irradiation certainly is indicated, since at this stage the development of delayed irradiation damage will trail the inevitable course of advanced pelvix carcinoma. (auth)

9958 HYPERTROPY OF SALIVARY GLANDS DURING THE CARCINOID SYNDROME. Bricaire, H.; Modigliani, E.; Joly, J.; Vilde, J. L. Ann. Med. Interne; 120: 85-96(1969). (In French).

An unusual and unexpected effect of irradiation in a case of carcinoid syndrome is reported. The illness started with symmetrical hypertrophy of the salivary and lacrimal glands. A few months later, a typical carcinoid syndrome developed together with liver metastases. Radiotherapy to the liver caused relief of symptoms and total regression of the salivary gland hypertrophy. Irradiation caused complete disappearance of the flushes in this patient which had resulted in permanent erythrocyanosis. In addition to the radioinduced normalization of salivary gland size and correction of the hepatomegaly, the excretion of 5-hydroxyindoleacetic acid became normal as a result of irradiation. These results are contrary to reports in the literature of the ineffectiveness of radiation in the treatment of carcinoid syndrome. Sixteen previous reports are reviewed in which radiotherapy was used, in doses varying from 1100 to 5500 R. The significance in the carcinoid syndrome of salivary hypertrophy, which seems to be a direct result of increased bradykinin secretion, is discussed. (BBB)

9959 ELECTRON MICROSCOPIC STUDY ON SQUAMATOUS CELL CARCINOMA OF UTERINE CERVIX, WITH SPECIAL REFERENCE TO INFLUENCE OF IRRADIATION ON CELL ORGANELLES. Ito, Shin (Kumamoto Univ., Japan). Acta Obstet. Gynaecol. Jap.; 16: 128-9(Apr 1969).

An electron microscopic study was made on normal squamous epithelium and squamous cell carcinoma of uterine cervix, and especially on the pathological changes of cell organelles after irradiation by Ra and ^{60}Co. Specimens were observed at 24 hr after irradiation and on postirradiation days 2, 5, 7, and 14 to observe serial changes in organelles. The cell membrane showed resistance to doses up to 1800 R. An aggregation of granules inside the cell membrane was seen. The intercellular space became dilated with increased radiation doses. As for cytoplasmic organelles, mitochondria were affected in the early periods of irradiation, and underwent swelling. Destruction of the mitochondrial membrane was seen at about 1800 R, and the membrane disappeared at 3000 R. Its cristae were frequently affected. Rough endoplasmic reticulum (ER) was more affected than smooth ER, both showing dilatation, disintegration, and disappearance of ribosome granules at about 1800 R. Granules with various electron densities appeared at about 1800 R in the cell matrix and larger granules (260 to 650 mμ in size) with and without a limiting membrane appeared at 4000 R and above. It is suggested that granules without a limiting membrane were produced in the process of degeneration of mitochondria. Changes of nuclear substance were observed at about 2000 R and soluble structures of the nuclear membrane disappeared at 8000 R and above. Fibroblasts, collagen fibers, and phagocytes were seen in the interstitium at about 3000 R, but phagocytes sometimes appeared earlier, or at about 1800 R. Endothelium of blood vessels showed swelling at 1000 R and shrinking at 3000 R. Changes in cytoplasmic organelles and matrix after 1 dose of irradiation of about 1800 R increased with time, but the progressive effect on the nucleus was slight. (BBB)

9960 HEMATOPOIETIC DISTURBANCES DUE TO THE TREATMENT OF FEMALE PELVIC MALIGNANT TUMORS. I. Sugimoto, Kunio (Niigata Univ., Japan). Acta Obstet. Gynaecol. Jap.; 16: 121(Apr. 1969).

The radiation injury due to local irradiation in therapeutic doses on the local or distant bone marrow and peripheral blood was investigated. Prior to irradiation, marrow aspiration and peripheral blood examination were performed in 60 patients with gynecologic malignant tumors. The patients were examined four to six times during conventional irradiation. In nonirradiated cases, in comparison with the normal values, decreases of nucleated cells and megakaryocytes numbers and reductions of proportion of erythroblasts and juvenile neutrophils were demonstrated in bone marrow. On the contrary, increases of the myeloid–erythroid ratio and lymphocytosis were seen in bone marrow. Depression of young erythroblasts was found, more markedly in the iliac marrow than in sternal marrow. Abnormalities of the myeloid–erythroid ratio were demonstrated according to age. Peripheral blood smears showed no significant changes. In irradiated patients, decreased numbers of nucleated cells and megakaryocytes were seen in bone marrow after irradiation, but nucleated cell counts tended to recover with cessation of therapy. On the other hand, recovery of the number of megakaryocytes to normal did not occur after repeated irradiation. The myeloid–erythroid ratio in the iliac marrow showed a significantly abnormal value after irradiation. (BBB)

9961 RADIATION INJURY. EFFECTS, PRINCIPLES, AND PERSPECTIVES. Upton, Arthur C. Chicago, University of Chicago Press, 1969. 133p.

The first section of the book is concerned with radiation sickness. Its relationship to radiation dosage and conditions of exposure, the symptoms and course of the illness, and treatment and repair of injuries are considered. Emphasis is placed on pathogenesis of the blood-forming organs, gastrointestinal tract, brain, gonads, and skin. The second section of the book is concerned with effects of radiation on growth, development and aging. Special attention is given to injury of the embryo and fetus. The third section deals with effects of radiation on the incidence of cancer and surveys the occurrence of cancer in irradiated human populations. The fourth section is concerned with prevention and control of radiation injury as related to public health. Public health implications of nuclear power plants, aerospace travel, civil defense, and medical irradiation are considered. A list of approximately 250 references and a subject index are included. (H.L.W.)

9962 COMPARISON OF THE OBSERVED RESULTS OF IRRADIATION ON THE SKIN WITH THOSE EXPECTED FROM AN IDEALIZED MODEL. Archambeau, J. O.; Mathieu, G. R. (Meadowbrook Hospital, East Meadow, N. Y.). Radiat. Res.; 40: 285-97(Nov 1969).

The evolution, time course and dose dependence of the moist reaction occurring following increasing exposures of x rays are summarized. Histologic and kinetic parameters of nonirradiated skin are reviewed. These data and known radiobiologic principles are used to construct a simple model to explain the effects of irradiation on the skin. The observed and predicted results are compared and several discrepancies are noted. The main ones were that the field was not uniformly involved and the time of healing was neither dose dependent nor time dependent. The significance of these findings are discussed. Possible modifications of the model are suggested and areas of future study are outlined. (auth)

9963 RADIATION HAZARDS FROM DIAGNOSTIC RADIOLOGY. Stedman, E. J. Brit. J. Radiol.; 42: 946(Dec 1969).

Comments are made on the 1969 survey by Mathews and Miller, that dealt with the population radiation doses arising from radiodiagnosis. It is particularly desirable to reduce the gonad dose where direct gonad irradiation is un-necessary. (UK)

9964 OTDALENNYE POSLEDSTVIYA LUCHEVOI TERAPII U DETEI. (Subsequent Effects from the Application of Radiation Therapy to Children). Mirimova, T. D. Leningrad; Izdatel'stvo Meditsina Leningradskoe Otdelenie (1968). 204p.

Clinical and laboratory studies of radiation effects on the nervous system, hemopoiesis, peripheral blood, soft tissues, skin, eyes, bones, teeth, and various organs in children who had experienced radiotherapy are analyzed. It was found that the latent effects of radiation develop slowly in children and become evident with their growth and development. More pronounced effects were observed in nervous disturbances in children exposed to early radiotherapy. A much stronger chronic radiosensitivity was observed in children exposed at an early age. Various measures for radiation protection are suggested. (251 References) (R.V.J.)

Radiation Effects on Plants

Refer also to abstracts 9696, 9737, 9768, 9778, 9781, 9804, 9812–9814, 9818, and 9877.

9965 COMPARATIVE STUDY OF THE PRINCIPLES OF THE INACTIVATION AND RECOVERY OF YEAST CELLS AFTER α AND γ-IRRADIATION. Petin, V. G. (Inst. of Medical Radiology, Obninsk, USSR). Radiobiologiya; 9: 421-6(1969). (In Russian).

It was shown that the distribution of yeast cells with respect to forms of inactivation for a given survival rate after α-irradiation proved to be the same as for the same survival rate after irradiation by γ-quanta. The survival rate unambiguously determined the distribution of the cells according to forms of inactivation, regardless of how this survival rate was achieved—after α- or γ-irradiation or as a result of recovery after one of these irradiations. The irradiation of yeast cells by α-particles is considerably more effective than α-irradiation. The magnitude of the irreversible component after α-irradiation is twice as great as that of the irreversible component after γ-irradiation; however, the probability of recovery from elementary damages per unit time is the same for α- and γ-irradiations. (tr-auth)

9966 REPAIRS OF CELLULAR STRUCTURES IN CONNECTION WITH TISSUE RADIOSENSITIVITY IN THE MERISTEM OF BARLEY ROOTLETS AFTER COMPARATIVE EFFECTS OF γ-RAYS AND RADIOTOXINS. Filippova, N. F. (Inst. of Biological Physics, Pushchino-on-Oka, USSR). Radiobiologiya; 9: 462-5 (1969). (In Russian).

The change in the cellular structures in the meristems of barley rootlets after the effects of nonlethal doses of γ-rays, as well as under the influence of low concentrations of radiotoxins, was investigated; the presence of repair during the development of the seedlings was demonstrated. The axial meristem is more radioresistant and is less damaged by γ-rays and radiotoxins. In the axial meristem, repair processes that depend both on the radiation doses and on the concentrations of radiotoxins also proceed more intensively. (tr-auth)

9967 DECREASE IN THE TOXICITY OF EXTRACTS FROM IRRADIATED PLANTS UNDER THE INFLUENCE OF GIBBERELLIN. Kryukova, L. M.; Nazarova, L. F. (Inst. of Biological Physics, Pushchino-on-Oka, USSR). Radiobiologiya; 9: 466-8 (1969). (In Russian).

The influence of gibberellin on the inactivation of anomalous radiotoxin metabolites, formed in plants irradiated with high doses of ionizing radiations of the order of several thousand R was demonstrated. The inactivating effect of gibberellin was demonstrated both in vivo in the case of local irradiation of one leaf of an intact plant and treatment of this leaf with gibberellin solution immediately after irradiation, and in vitro under the action of gibberellin solutions on extracts isolated from irradiated plants. (tr-auth)

9968 INFLUENCE OF EXTERNAL γ-IRRADIATION OF HIGHER AQUATIC PLANTS ON THEIR ACCUMULATION OF ^{90}Sr, ^{137}Cs, AND ^{144}Ce. Leinerte, M. P. (Inst. of Biology, Riga). Radiobiologiya; 9: 427-32(1969). (In Russian).

Preliminary irradiation of experimental plants (Lemma minor L., Ceratophyllum demersum L., Elodea canadensis Rich.) had a negligible influence on the coefficients of accumulation of strontium-90. The accumulation of cesium-137 is sharply reduced with increasing irradiation dose, while the coefficients of accumulation of cerium-144 are slightly increased after preliminary irradiation. (tr-auth)

9969 RADIATION-INDUCED EASY PEELING AND OBLONG FRUIT MUTANTS OF THE TOMATO. Verkerk, K.; Contant, R. B. (Agricultural Univ., Wageningen, Netherlands. Netherlands Inst. for Atomic Sciences in Agriculture, Wageningen). Neth. J. Agr. Sci.; 17: 221-8(1969).

In the course of investigations on the mutagenic effectiveness of thermal neutrons and x rays on tomato seeds, two mutants were found having fruit characteristics considered to be of potential practical interest. Their genetics and certain of their phenotypic, agronomic, and technological features were studied. (auth)

9970 RECOVERY OF VIABILITY AND RADIATION RESISTANCE BY HEAT-INJURED CONIDIA OF PENICILLIUM EXPANSUM LK. EX THOM. Baldy, Richard Wallace. Davis, Calif.; Univ. of California (1968). 51p.

Thesis.

Spores heated in water at 54°C for up to one hour were either immediately plated on nutrient agar or held three days in aerated water at 23°C before plating. Holding heated spores under these conditions was optimal for recovery and increased the percent of survival up to twentyfold over immediate plating values. But recovery was partially or completely prevented if spores were held in any of the following solutions: glucose, potassium phosphate, ammonium or sodium acetate, sodium azide, 2,4-dinitrophenol, or in the sodium or potassium salts of pyruvate, TCA cycle acids and ATP. Both anaerobiosis and 0°C prevented recovery. Survivors of a heat treatment were more sensitive than unheated spores to gamma radiation. Conditions which affected recovery of viability had the same effect on restoration of radiation resistance. We conclude that many of the processes for restoration of radiation resistance are also involved in recovery of viability after heating. After a 99% inactivating treatment (about 30 minutes at 54°C) heated spores respire as fast or faster than unheated spores. Malate, citrate, succinate, acetate and 2,4-dinitrophenol stimulate respiration of unheated spores while they inhibit respiration of heated spores. Evidently recovery requires respiration. We speculate that heated spores held in substrates may accumulate ATP because heating disrupts many synthetic processes utilizing ATP. By inhibiting key reactions in the glycolytic and TCA pathways, ATP may block respiration and the sources for the simple compounds used in replacing heat damaged cellular components. (Diss. Abstr.)

9971 STUDY OF THE INFLEXION IN X-RADIATION SURVIVAL CURVES FOR SYNCHRONIZED CELL POPULATIONS OF THE GREEN ALGA (OEDOGONIUM CARDIACUM). Horsley, R. J.; Pujara, C. M. (Ontario Cancer Treatment and Research Foundation, Hamilton). Radiat. Res.; 40: 440-9(Nov 1969).

It is known that cells irradiated at increasing ages in the cell cycle yield survival curves with different radiation response parameters, namely D_0 and n. The parameters D_0 and n have been determined during the first cell cycle of Oedogonium cardiacum and both factors vary in the same direction with cell age, changing by maximum factors of 7 and 25 respectively. Previously it was reported that synchronized cultures of Oedogonium cardiacum cells irradiated late in the first cell cycle yield dose response curves exhibiting a pronounced inflexion point. In this paper, calculated survival data are presented to show how the presence of this inflection point is influenced by relative changes in both magnitude and direction of the response parameters of two subpopulations (S and G_2 cells) whose radiosensitivity is represented by the initial and latter portions of the complex survival curve. An inflection point is evident in the survival curve if the difference in either of the parameters is relatively large, but furthermore, the inflection point is much more pronounced if both parameters vary in the same direction with cell age. Conversely, if the pa-

rameters vary in the opposite direction, the inflection point present in the survival curve is minimized. (auth)

9972 INFLUENCE OF γ-IRRADIATION ON THE POLLEN FORMATION OF THE MORACEAE. Tojo, Isao (Sericultural Experiment Station, Tokyo). Sanshi Kenkyu; No. 70, 22-33 (Jan 1969). (In Japanese).

The influence of γ rays on the growth of male flower buds and pollen grains, and the formation of four pollen grains was investigated in the sprouts of moraceae developed in winter. After cutting and storing at 3 to 5°C, twigs of each Morus alba Linn. were γ-irradiated at 2.5 to 10.0 kR. The dose rate to the winter sprouts of the twigs was 5 kR/h at 17.5°C. Growth reduction in the flower buds was increased as the dose increased. At 2.5 to 7.5 kR, almost all flower buds were stripped and the anthers were dehisced, while at 10.0 kR, reduced growth of most flower buds, some dehiscence of anthers, and no perfect pollen grains were observed. When the applied dose was large, sizes of the pollen grains were variable, and many inferior pollen grains were produced. Many pollen grains had more than three sprouting pores. The formation of abnormal pollen grains was caused by abnormal karyokinesis of the pollen mother cells and abnormal four cell formation, caused by the irradiation. With an increase of the dose, abnormalities such as early disaffection of chromosomes, delayed chromosomes, nucleoli formation, formation of non-reduced gametophytes, abnormal arrangement of nuclear plates, disorder of chromosome separation, two nucleus formation, chromosome bridge, macropollen mother cells, 1 to 3 cells, abnormal four-cell formation, four cells containing wrong microspores, and 5 to 15 cells or macro four cells, were observed frequently. (TSS) (NSA of Japan)

Radiation Effects on Microorganisms

Refer also to abstracts 9804, 9816, 9819–9821, and 9979.

9973 EFFECT OF DEUTERIUM OXIDE ON THE HEAT STABILITY OF STAPHYLOPHAGE. Popov, Yu. B.; Lapshin, Ey. A. (Khabarow Medical Inst., USSR). Biophysics (USSR) (Engl. Transl.); 14: 198-9(1969).

Translated from Biofizika; 14: (1969).

Heavy hydrogen water inhibited the thermal inactivation of staphylococcal bacteriophage. At the end of 18 hours incubation at 48°C, the mean concentration of viable phage was: 668 in water with 0% deuterium oxide; 880 with 0.009%; 552 with 0.9%; 1395 with 0.9%; 649 with 9% and 7090 with 90%. An inhibitory effect was exerted only by high concentrations of deuterium oxide. (UK)

9974 STUDIES ON REACTIVATION IN THE POXVIRUS GROUP. III. REACTIVATION OF THERMALLY INACTIVATED VACCINIA VIRUS BY UV-IRRADIATED VACCINIA VIRUS. Mazur, Benedykt (Academy of Medicine, Poznan, Poland). Med. Dosw. Mikrobiol.; 21: 175-82(1969). (In Polish).

Reactivation of heat-inactivated vaccinia virus by uv-irradiated vaccinia virus was investigated in Hep-2 cell cultures. Heat inactivation was carried out at 56°C for 90 or 120 min or at 60° for 10, 12, or 15 min. The uv-irradiated virus was exposed at 56 cm from a 5300 Hanau lamp for 5 to 15 min. It was found that virus exposed for 5 or 8 min and completely inactivated during uv-irradiation produces a cytopathogenic effect but does not reproduce at high titers during further development. This virus, mixed in certain proportions with heat-inactivated virus, produced an increase in the cytopathogenic effect during first days of incubation; however, final titers remained low. Infection of cell cultures with mixtures of completely inactivated viruses resulted in a sporadic cytopathogenic effect, the frequency of which was increased by passaging, especially after treatment of the infected cell line with ultrasound (30 sec at 18 kHz). The mechanism of reactivation and the influence of interference are discussed. (BBB)

9975 AN OXYGEN-DEPENDENT X-RAY DOSE-RATE EFFECT IN SERRATIA MARCESCENS. Dewey, D. L. (Mount Vernon Hospital, Northwood, Eng.). Radiat. Res.; 38: 467-74 (Jun 1969).

Anoxic bacteria were found to be independent of x-ray dose rate between 167 and 2130 rads/min. Fully aerobic bacteria were less sensitive to radiation at low dose rates. Aerobic bacteria at very low oxygen tensions were more sensitive to radiation at low dose rates. A possible explanation for the observed phenomenon is to assume repair of radiation damage. Repair of radiation damage in Serratia was demonstrated by preliminary uv treatment. At the lowest oxygen tension a change in the observed K value with dose rate demonstrated oxygen depletion by radiation. Measurements of K values at conventional dose rates are liable to be in error unless gas equilibration is very efficient. (auth)

Radiosterilization and Radiopreservation

Refer also to abstracts 9550 and 9865.

9976 (GA-9632) APPLICATION OF IONIZING RADIATION TO THE TREATMENT OF WASTE WATERS AND SEWAGE SLUDGE. Compton, D. M. J.; Black, Sandra J.; Lieurance, F. L.; Whittemore, W. L. (Gulf General Atomic, Inc., San Diego, Calif.). 8 Aug 1969. Contract AT(04-3)-167. 22p. (CONF-690805-6). Dep. CFSTI.

From Symposium on Utilization of Large Radiation Sources and Accelerators in Industrial Processing, Munich, Germany.

The use of ionizing radiation for sewage treatment was investigated to determine the effectiveness and cost of this method. Previous studies on disinfection by irradiation, the removal of organic impurities, and the effects of irradiation on biodegradability of waste materials and on the filterability and settleability of waste sludge were analyzed. It is concluded that irradiation is not an economically competitive process for oxidation of organic impurities in waste waters nor as a conditioning agent in sludge filtration. Irradiation does produce potentially useful effects in enhancing the settling of sludge, and further work on this is continuing. (L.C.L.)

9977 (TID-25230) 90-DAY SUBACUTE ORAL TOXICITY STUDIES ON RADIATION: PASTEURIZED FOODS (STRAWBERRIES, APPLES, AND PEARS). Final Report. Calandra, J. C.; Ives, Margaret (Industrial Bio-Test Labs., Inc., Northbrook, Ill.). Sep 1965. Contract AT(11-1)-1318. 153p. Dep. CFSTI.

The results of 90-days of feeding a series of low-dose gamma irradiated fruits (strawberries, apples and pears) to groups of albino rats and beagle dogs at dietary levels of 35 per cent by weight revealed no adverse effects in any of the 10 biological parameters investigated. The findings for animals fed irradiated fruits were comparable to those of animals fed non-irradiated fruits. (auth)

9978 EFFECT OF IONIZING RADIATION ON DEVELOPMENT OF DERMESTES MACULATUS. Pointel, J.-G.; Pham Van Sam, M. (IRAT, Nogent sur Marne, France). J. Stored Prod. Res.; 5: 95-109(Aug 1969). (In French).

Within the frame of a scheme relating to the establishment of a plant in Mali to control the stored-product insects of dried and smoked fish the authors have studied the sterilizing effect of gamma irradiation on the main pest, Dermestes maculatus Deg. Larvae, nymphs and adults of D. maculatus were irradiated at doses ranging from 10 to 30 krad. None of the treated stages gave any progeny and their life span was shortened. (auth)

9979 THE EFFECT OF COMMERCIAL FOOD PROCESSING VARIABLES ON THE INACTIVATION OF CLOSTRIDIUM BOTULINUM BY IONIZING RADIATION AT LOW TEMPERATURES. Snyder, Oscar Peter, Jr. Amherst, Mass.; Univ. of Massachusetts (1969). 88p.

Thesis.

The sterilization of C. botulinum 33A and 53B by ^{60}Co γ radiation was measured in substrates of beef, pork, chicken, and ham, at temperatures of 20° to −180°C and pressures of 760 to 50 Torr. The results showed that lethality for both organisms follows multihit kinetics characterized by a target number of approximately 16. Type 33A was consistently more resistant than 53B. Resistance of the organisms increased as the temperature and pressure were reduced. The order of resistance in the substrate was: chicken > beef > ham > pork. Using data for type 33A in beef, a set of conversion constants was derived which allows the prediction of exponential inactivation rates for type 53B in the four substrates. Energy of activation values derived from the experimental data for the influence of temperature on irradiation ranged from 21.9 cal/mole at −130° to −180°C to 595 cal/mole at 5° to 20°C. A molecular weight calculation of the target size gave a value of approximately 6×10^6. (Diss. Abstr.)

9980 THE EFFECT OF GAMMA IRRADIATION AND STORAGE ON THE CONTENT OF SUGAR IN THE ONION BULB. Tada, Mikiro; Shiroishi, Masahide (Okayama Univ., Japan). Okayama Daigaku Nogabuku Gakujutsu Hokoku; No. 33, 71-5(Mar 1969). (In Japanese).

The effect of γ irradiation on the content of sugar in onion bulbs during storage at room temperature and at 1°C was studied. Onion bulbs, Sapporo yellow, were irradiated with a dose of 7000 or 15,000 rad from a ^{60}Co γ source at Takasaki Laboratory, Japan Atomic Energy Research Institute, soon after harvest and after storage for 1 month at room temperature. The experimental result showed that the content of sugar in onion bulbs was not

significantly changed by either irradiation or by storage temperature. (NSA of Japan)

9981 APPARENT VISCOSITY OF SHRIMP HOMOGENATE AS A QUALITY INDEX OF SHRIMP IRRADIATED AT CRYOGENIC TEMPERATURES. Rhee, Joon Shick. Baton Rouge, La.; Louisiana State Univ. (1969). 102p.

Thesis.

The practicality and usefulness of several physical and biochemical analytical methods for estimating the quality of shrimp were investigated. Because of the complexly interrelated parameters which are involved in the spoilage processes, it is very difficult to assess the degree of spoilage with any single method of analysis. The analytical approach included the viscometric technique. Since proteins, apart from water, are the main constituents of shrimp tissue, denaturation of proteins has been considered to be a predominant factor in the spoilage processes. A search was made for relationships between the degree of spoilage and the apparent viscosity of the shrimp homogenate. Experimental results showed that the apparent viscosity of the non-irradiated shrimp homogenate increased in proportion to the length of time that the shrimp had been in ice storage. Non-irradiated putrefied shrimp always showed very high viscosities. Fresh shrimp always showed low viscosities. These findings suggest that the apparent viscosity of the homogenate could be used as a quality index for non-irradiated shrimp. The apparent viscosities of irradiated shrimp were of the same order of magnitude as those of the non-irradiated controls for each week of ice storage. However, the irradiated shrimp were neither slimy nor did they smell bad even after 21 days of ice storage, whereas the non-irradiated controls were slimy and developed putrid odors after 14 days of the storage. The observed similarities in magnitude of the apparent viscosities of the irradiated shrimp and their non-irradiated controls may be accounted for by the following two factors: radiation effects that denature proteins in the shrimp tissue, and the activity on the denatured proteins of microbial flora that have survived irradiation. At either 25°C or −30°C, irradiation with 0.1 Mrad denatured less protein and possibly other constituents of shrimp than did irradiation with 0.4 Mrad. Similarly, irradiation with either 0.1 Mrad or 0.4 Mrad produced less protein denaturation at −30°C than at 25°C. Of all the radiation-treated samples, irradiation with 0.1 Mrad at −30°C gave shrimp having the lowest apparent viscosity; associated with these low values were four other criteria that indicated a superior product, namely, highest ERV, smaller total bacterial count, absence of black spots, and highest organoleptic scores. Extractability values of the sarcoplasmic and total soluble proteins of the non-irradiated shrimp and the shrimp irradiated with 0.4 Mrad at 25°C and subsequently stored in ice were found at the end of 21 days to be appreciably less than their initial values. The amounts of non-protein nitrogen were inversely proportional to the length of the ice storage period. The centipoise values of the apparent viscosity of the shrimp homogenate were correlated with data for seven other indices of quality. The results showed that the correlation with total bacterial count was positive and significant ($p < 0.05$); with ERV, overall organoleptic scores, and appearance of shrimp the correlations were negative and significant ($p < 0.05$); the correlation with odor was negative and highly significant ($p < 0.01$); whereas the correlation with flavor and texture was negative but was not significant ($p < 0.05$). (Diss. Abstr.)

9982 PROTECTION OF CEREALS BY GAMMA RAYS. Deschreider, A. R. Vitalst. Zivilisationskr., 14: No. 2, 73-6(1969). (In French).

Ionizing radiations improve the preservability of cereals and other foodstuffs when the traditional measures against infestation are not sufficient. The action of gamma irradiation on different insects species and the technical and economic aspects of the process are reviewed. The harmlessness, the lack of toxicity and of cancerogenic action of the treatment are demonstrated, and the existing or projected installations are described. It can be predicted that the consumption of irradiated cereal and similar products treated with doses between 0.02 and 0.05 Mrad is not dangerous for man. On the other side, the rheological properties and the nutritive value of the products are not affected. (auth)

9983 STUDIES ON THE ECOLOGY OF INSECTS STERILIZED ARTIFICALLY (GAMMA RADIATION). 3. EFFECTS OF ^{137}Cs ON THE STERILITIES OF SPODOPTERA LITTORALIS (BOISD). Kiyoku, Masao; Tsukuda, Ritsuko (Okayama Univ., Japan). Nippon Oyo Dobutsu Konchugaku Zasshi, 13: No. 2, 61-9(June 1969). (In Japanese).

The optimum dosage of ^{137}Cs for sterilizing Spodoptera littoralis (Boisd.) and the most suitable stage for irradiation with gamma rays were examined. Five-day-old pupae seemed to be a suitable stage for irradiation. The optimum dosage for complete sterilization were 24 kR for males and 20 kR for females. The reduction in longevity of both sexes, irradiated at these dosages, was not significant and few adult deformities appeared. Next, sexual behavior of adults and the alternate mating with a sterilized and untreated male to a normal female were investigated. A male could mate continuously with five virgin females during its life period. A female generally mated once again with the same male but it was sometimes observed that a female that had already mated once copulated again with other virgin males. Virgin females were mated first with males irradiated at 20 kR and five days later with normal males. The females produced almost no viable eggs until the subsequent mating with normal males, and after copulation with normal ones they produced, nevertheless, considerably fewer viable eggs as compared with the control. On the other hand, when virgin females were mated first with normal males and five days later with irradiated ones, they produced as many viable eggs as the control. Experiments on the mating competitiveness between males and females, both sterilized and normal ones, were conducted. When three irradiated males or two irradiated females were introduced into a confined population containing a normal male and female, the hatch percentages in eggs that were laid by a normal female were 1.3 or 1.9%, respectively. Introducing both irradiated male and female, it was 32.4%. Both the experimental values of 1.3 and 1.9% were considerably lower but that of 32.4% was higher than the theoretically estimated values. (auth) (NSA of Japan)

METALS, CERAMICS, AND OTHER MATERIALS

Metals and Alloys

Refer also to abstracts 9548, 9610, 10133, 10145, and 11104.

9984 (BNWL-1201-1) SODIUM TECHNOLOGY QUARTERLY REPORT, JULY-SEPTEMBER 1969. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Nov 1969. Contract AT(45-1)-1830, 140p. Dep. CFSTI.

Research progress is reported in five sections. A separate abstract was prepared for each section. (J.R.D.)

For abstracts of individual sections see: 9548, 9985, 10034, 10035, and 10155.

9985 (BNWL-1200-1, pp 4.1-30) SODIUM ANALYSES. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

A mockup facility for the development of remote methods of analysis for sodium is under construction. The air atmosphere portion has been completed and equipped with manipulators. Mechanical testing of equipment for oxygen and hydrogen determinations is under way. The inert-atmosphere portion of the mockup has been designed and construction is in progress. A removable section bypass loop sampler designed for remote operation has been installed on the small components test loop and equipped with manipulators. Preliminary specifications for methane and carbon monoxide concentrations in FFTF cover gas have been issued. Reaction rate measurements between sodium and carbon dioxide in the cover gas have been made. An investigation of the inhibiting effect of oxygen on the nitriding of stainless steel has been conducted, and recommendations have been made concerning the minimum desirable oxygen concentration in the FFTF nitrogen cover gas system. An evaluation of the Bendix MA-1 TOF mass spectrometer as a tool for the monitoring of trace levels of impurities in FFTF sodium cover gas has been completed. Laboratory evaluation of four sodium vapor trap designs has been completed. Analysis of the processes of mass and heat transfer that occur in sodium vapor traps is under way, and the bases for trap design and temperature profiles have been established. A prototypical trap has been constructed, and laboratory evaluation has begun to verify that the equations will adequately predict trap performance. A new vapor trap design has been conceived based upon a revaporization principle. A laboratory prototype has been constructed and evaluation begun. A program has been initiated to measure the quantities of impurities that are removed from argon during cooling and removal of sodium vapor. The initial work has been performed with hydrogen. Improvements in the procedures for determination of total carbon and hydrogen in sodium have been made. Service analyses have been performed. Programs have been initiated to extend present analytical capabilities to include methods for carbon containing species and particulates in sodium. (auth)

9986 (GEMP-1012(Pt.1)) AEC FUELS AND MATERIALS DEVELOPMENT PROGRAM. Eighth Annual Report. (General Electric Co., Cincinnati, Ohio. Nuclear Systems Programs). Mar. 31, 1969. Contract AT(40-1)-2847. 382p. Dep. CFSTI.

Development progress is reported in three sections. A separate abstract was prepared for each section. (J.R.D.)

For abstracts of individual sections see: 10013, 10039, and 10114.

9987 (KFK-985) CANNING MATERIALS FOR FAST BREEDER REACTORS. Discussion Meeting on December 5 and 6, 1968 in Karlsruhe. Boehm, H. (comp.) (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Material- und Festkoerperforschung). July 1969. 454p. (In German and English). (CONF-681220).

Twenty-five papers were presented at the meeting. A separate abstract was prepared for each of twenty-four papers. The paper for which no abstract was prepared contained discussions of work reported in an abstracted paper on fuel element canning materials. (J.R.D.)

For abstracts of individual papers see: 9610–9612, 9988, 9989, 9996–10000, 10014, 10040–10044, 10079, and 10116–10122.

9988 (KFK-985, pp 1-16) STRESS OF THE FUEL ROD CAN IN FAST BREEDER REACTORS. Kummerer, K. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Material- und Festkoerperforschung). (In German).

The basic operational and safety requirements for fuel rod cans are that the can is leakproof and that the external geometry of the fuel rod does not change over the entire operational time. The most important specifications for the stress of the canning material are tabulated. The problem of canning material research and development is to support the prevailing empiricism by basic data and to make available canning material or metal alloys with these specifications in a technically usable form. (tr-auth)

9989 (KFK-985, pp 93-112) CARBON TRANSPORT IN A SODIUM SYSTEM. Hofer, Gerhard (Siemens A. G., Erlangen (West Germany)). (In German).

The three-phase range in the three-component system Na–C–O was determined at 25, 677, 687, and 760°C with the help of a thermodynamic analysis. The activities of carbon and oxygen of the three-phase range adjacent to the sodium are given. (tr-auth)

9990 (NRL-6975) DYNAMIC TEAR ENERGY: A PRACTICAL PERFORMANCE CRITERION FOR FRACTURE RESISTANCE. Lange, E. A.; Loss, F. J. (Naval Research Lab., Washington, D. C.). 19 Aug 1969. 20p.

The Dynamic Tear (DT) method of testing for fracture toughness was developed to overcome the limitations of the Charpy V (C_v) test and to provide information of engineering design significance. Key features of the DT test are described, including specimen design, impact test machines, and methods of energy measurement. A relationship exists between the DT energy and the fracture mechanics stress-intensity factor K_{Ic} which allows the translation of these energy values into design parameters, such as critical flaw size and stress level, by means of suitable charts. The current need for the use of the DT test in the development and selection of high-strength structural metals has become evident through examples of conditions to which the C_v test has been shown to be inadequate. For example, when fracture toughness criteria defined by the C_v and DT tests are compared for a high-strength titanium alloy, a 180-ksi yield strength steel, a 140-ksi yield strength steel weld metal, and a Q & T 2¼% Cr–1% Mo steel of 90-ksi yield strength, the C_v test is shown to provide information in variance to that from the DT, DWT-NDT, and Robertson tests. Therefore, it is concluded that the DT test method has desirable features for general industrial use which provide broad-scope characterization of the fracture resistance of steels, titanium alloys, and aluminum alloys. (auth)

9991 THE LONG-TERM DESIGN OF THE ENERGY SUPPLY OF THE FEDERAL REPUBLIC OF GERMANY. Mandel, Heinrich. Stud. Gen.; 22: 630-42(6 Jun 1969). (In German).

The role of nuclear energy in power generation is discussed. The fraction of electrical power produced by nuclear means could reach 15% by the end of the 60's, 70% by 1980, and thereafter approach 80% asymptotically. Output of another model suggests 25,000 MW(e) for nuclear power stations in 1980. This model has a strong displacement effect of nuclear power stations on the installation of conventional stations. The only solution to fuel problems by 2000 is nuclear energy. Discussion of U reserves, the eventual lack of influence of the price of U on current production costs, use of U in present types of reactors, import dependence of the Federal Republic for nuclear energy, foreign exchange requirements in the electrical economy, and the safety of nuclear power installations are illustrative of problems associated with the transition lying ahead. (BBB)

Corrosion and Erosion

Refer also to abstracts 9597, 10077, and 11212.

9992 (AI-AEC-12898) CORROSION OF TYPE 316 STAINLESS STEEL WITH SURFACE HEAT FLUX IN 1200°F FLOWING SODIUM. Hopenfeld, J. (Atomics International, Canoga Park, Calif.). 30 Nov 1969. Contract AT(04-3)-701. 32p. Dep. CFSTI.

In a sodium cooled reactor, the surface temperature of the cladding and the bulk liquid temperature increase along the channel, as a result of heat generation in the fuel. The difference between the solubility of the corrosion products at the local surface temperature and the corresponding concentration of the corrosion products in the bulk of the sodium provides the driving force for cladding corrosion. The ability to predict this corrosion rate is a prerequisite for proper cladding design and system maintenance. A method is provided for estimating the corrosion rate of the cladding when the sodium at the entrance to the fuel channel has an oxygen content <5 ppM and is saturated with respect to the corrosion products. The predictions are based on experimental data of local corrosion rates, which were measured along a 3.5-in. sectional cladding sample. The 55°F temperature rise along the surface of the sample was achieved by subjecting the surface to

a heat flux of ~10^6 Btu/ft^2-hr. From the observed dependence of the local corrosion rate on the velocity (10 and 20 ft/sec), it was concluded that the corrosion rate is controlled by liquid diffusion. In order to obtain agreement of the corrosion rates derived from the theoretical equations with rates which were measured, it was necessary to use the lowest published solubility data of iron in sodium. The diffusion coefficient of iron in sodium was assumed to be that which had been published for the self-diffusion of sodium in liquid sodium. In addition to the total weight loss measurements, the preferential dissolution rates of chromium and cobalt are also presented. (auth)

9993 (BNL–14225) MEASUREMENTS OF THE SOLUBILITY OF IRON AND CHROMIUM IN SODIUM. Singer, R. M.; Fleitman, A. H.; Weeks, J. R.; Isaacs, H. S. (Brookhaven National Lab., Upton, N. Y.). 1968. 16p. Dep. CFSTI.

The solubilities of Fe, Cr and Ni have been measured in liquid Na. Iron is more soluble than Ni and Cr in Na at T > 600°, yet Ni and Cr are selectively leached from stainless steels during corrosion. Concentrations of Fe and Cr in circuit Na (low oxygen) generally approximate their solubilities at T_{max}, whereas concentrations of Ni are generally less than its solubility at T_{max}. The location of Ni and Cr deposits as described by Roy et al. and by Bogers was shown to be consistent with the temperature dependence of the Ni and Cr solubilities. (auth)

9994 (BNL–14230) THE CORROSION AND MASS TRANSFER OF PURE IRON, NICKEL, CHROMIUM, AND COBALT IN 660° TO 760°C SODIUM. Fleitman, A. H.; Isaacs, H. S. (Brookhaven National Lab., Upton, N. Y.). [1969]. 11p. Dep. CFSTI.

Specimens of high purity Fe, Cr, Ni, and Co were exposed to Na at 660 to 760°C in a 316 stainless steel loop. Results of the tests show that all the Ni, Fe and Co specimens are etched, i.e., the grain boundaries are attacked. The Cr specimens are similarly affected except for those in the 112 ppM oxygen Na. These latter specimens have a dark grey film. Ni specimens lose weight (1–2 mg/cm^2 maximum) while Fe and Co specimens gain weight (~0.7–0.8 mg/cm^2 maximum). The larger weight changes occur at the higher temperatures. Cr specimens undergo little or no weight change. Mass transfer of Fe, Ni, Cr and Co occurs. As the oxygen concentration in Na is increased from 4 to 110 ppM, deposition of Fe increases sharply, deposition of Ni is unchanged and deposition of Cr is increased slightly. Only traces of Co deposition were found. (J.R.D.)

9995 (GEAP–10044) SPECIFIC ZIRCONIUM ALLOY DESIGN PROGRAM. FINAL SUMMARY REPORT. Klepfer, H. H.; Mehner, A. S. (comps.) (General Electric Co., San Jose, Calif. Nuclear Fuels Dept.). Jun 1969. Contract AT(04-3)-189. 134p. (EURAEC–2130). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

The objective of the program was to develop a Zr–Cr alloy as a functional cladding. Data accumulated on the mechanical and physical properties of the Zr–Cr alloy, and the detailed results of the irradiation program up to June 30, 1969 are presented. A Zr + 2.0 at. % Cr + 0.16 at. % Fe alloy (Zr–Cr) with superior high temperature corrosion resistance has been developed. A commercially feasible process has also been developed and successfully used to fabricate significant quantities of tubing and bar stock from large ingots of the alloy. Characterization tests confirmed this process to result in tubing with excellent high-temperature (up to 500°C) steam autoclave corrosion resistance. The mechanical properties of the tubing were equivalent to present Zircaloy-2 fuel cladding. Zr–Cr alloy clad fuel rods have been successfully irradiated in the Consumers Big Rock Point reactor to an average exposure of 14,300 MWd/tU. The Zr–Cr clad fuel rods have performed as well as, and often better than, Zircaloy-2 clad fuel rods under similar irradiation conditions. During the last BRP irradiation cycle, the Zr–Cr cladding received a stringent test of its primary performance advantage, i.e., improved corrosion resistance at overtemperature conditions. Crud deposition during the cycle was abnormally high, leading to cladding surface temperatures significantly beyond design limits. Under these conditions, one Zr-2 rod in the bundle failed, while all Zr–Cr rods remained intact. A detailed post-irradiation examination to evaluate the corrosion behavior of the Zr–Cr alloy as fuel cladding has been performed on nine fuel rods (six Zr–Cr clad rods and three Zr-2 clad rods) irradiated to an average exposure of 8000 MWd/tU (7900 hours), and two dummy rods exposed for 7900 hours. For these exposures, the Zr–Cr alloy performed satisfactorily as a fuel rod cladding. Oxide film thickness measurements taken on the Zr–Cr fuel cladding and the Zircaloy-2 fuel cladding indicate the Zr–Cr alloy's corrosion behavior in-pile at these exposures is as good as or better than the corrosion behavior of Zircaloy-2. Long-term, out-of-pile, loop corrosion tests have been performed on the Zr–Cr alloy and Zircaloy-2. The corrosion loop simulates the environments (including heat transfer) fuel rods would be exposed to in a boiling water environment. The results of these corrosion tests after 7800 hours exposure were compared with the in-pile corrosion results, and the effects of heat transfer, irradiation, and surface pretreatment on the corrosion rates of the Zr–Cr alloy were evaluated. Up to 7800 hours exposure, heat transfer conditions have no effect on the corrosion rate of the Zr–Cr alloy. Irradiation enhances the corrosion rate of both the Zr–Cr alloy and the Zr-2 alloy. The effect of surface pretreatment on the corrosion rates of the Zr–Cr and Zr-2 alloys is not clear; however, there are indications that the corrosion increases with higher temperature autoclave prefilms. (auth)

9996 (KFK–985, pp 71-91) CORROSION OF CANNING MATERIALS FOR FAST BREEDER REACTORS IN LIQUID SODIUM. Borgstedt, Hans Ulrich (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Material- und Festkoerperforschung). (In German).

Corrosion behavior of steels and nickel alloys was studied, especially with respect to the qualitative phenomena of mass transport and its origin, as well as the time law of sodium corrosion and its dependence on the parameters of temperature, flow rate, and oxygen content. The unsatisfactorily defined downstream effect represents a significant gap in the knowledge of quantitative corrosion behavior. There is also the difficulty of translating material corrosion to a reactor circuit. The present knowledge on the behavior of vanadium alloys in liquid sodium is the basis for sodium purity standards which permits the use of this material. The high sensitivity of vanadium alloys to impurities in sodium establish the requirement that materials in cooling circuits do not produce sodium which can react with vanadium alloys. The examinations on the dangers arising from the internal oxidation of some vanadium alloys indicate alloy development in the direction of element combinations with significantly low oxygen affinities than alloys with Ti or Zr indicate. Both steels and nickel alloys can be used in liquid sodium only under limited conditions. The austenitic steel is usable up to a temperature range of 650°C and vanadium alloys in the range of very low oxide content of the sodium. (tr-auth)

9997 (KFK–985, pp 113-33) CORROSION IN GASEOUS COOLANTS. Leistikow, Siegfried (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Material- und Festkoerperforschung). (In German).

The corrosive behavior of hot steam, carbon dioxide, and helium outside the reactor and of hot steam, carbon dioxide, and oxygen under irradiation was investigated on the canning materials used in steam and gas cooled reactors. Comparative studies showed that steam was relatively the most aggressive, although at fuel element surface temperatures not more than 700°C under optimum yield it can be used in the direct circuit of a breeder reactor. Under these conditions higher alloyed Cr–Ni steel, as Incoloy 800, can be used as canning material. The carbon dioxide coolant of a breeder reactor must be operated at comparative efficiency in the direct circuit at higher gas output temperatures. From data on the corrosion stability and strength, corresponding surface temperatures of a maximum of 800°C can be used only in the use of nickel-base alloys, such as Hastelloy X or Inconel 625, as canning material. Neutron economy and radiation embrittlement argue against their use. For the helium cooling of a breeder reactor with comparable efficiency in the direct circuit — under the assumption of a gas turbine for helium of 750°C — surface temperatures of at least 900°C are necessary. The required corrosion stability and strength are possessed by nickel-base and vanadium-base alloys in this temperature range. (tr-auth)

9998 (KFK–985, pp 135-59) COMPATIBILITY OF CANNING MATERIALS WITH NUCLEAR FUELS. Goetzmann, O. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Material- und Festkoerperforschung). (In German).

The compatibility of Al, Fe, Ni, Ti, Zr, V, Nb, Cr, and Mo with UC, UN, and UO_2 was investigated at various temperatures. The results were tabulated. Compatibility tests were also made with UN and UO_2 for vanadium and vanadium–titanium alloys, iron-base alloys, and nickel-base alloys. The results showed that pure vanadium is much more compatible with UN than the V–Ti alloys. The oxidation of UN decreases with increase of the Ti content. In V alloys with 20% Ti a strong diffusion of uranium from UN occurs at temperatures of 800°C and above. The Ti content in V alloys critical for compatibility with UO_2 is about 10%. The formation of UNi_5 is the compatibility-determining reaction between UN and the iron-basis and nickel-base alloys. The alloys with the lowest Ni content, non-rusting steel of the type V2A are the most compatible with UN. With UO_2 the iron-base and nickel-base alloys are very compatible up to the melt-

ing point of the system. The compatibility of UN with titanium alloys decreases with increasing titanium content. The situation is similar with iron-base and nickel-base alloys. (J.S.R.)

9999 (KFK-985, pp 303-12) Ni-Cr-Fe ALLOYS FOR POSSIBLE APPLICATION AS CANNING MATERIALS. Twigg, P. L. (International Nickel Ltd., Birmingham (England)).

Development of a corrosion resistant alloy composed of Cr-25%, Ni-44%, and balance Fe for fuel canning material is described. The effects of age hardening on this alloy are discussed along with it's corrosion resistance to coal firing environments incorporating sodium chloride. (J.R.D.)

10000 (KFK-985, pp 365-401) DEVELOPMENT OF HIGH-TEMPERATURE-STABLE AND CORROSION-RESISTANT VANADIUM ALLOYS. Ruehle, M. (Metallgesellschaft A. G., Frankfurt am Main (West Germany)). (In German).

The results obtained since 1964 at the Karlsruhe Nuclear Research Center on the development of high-temperature stable and corrosion-resistant vandium alloys are summarized. The research was centered on vanadium alloys mixed-crystal hardened with Ti, Cr, Nb, and Mo in which the neutron economy is maintained. The ductility of most mixed-crystal hardened vanadium alloys was significantly improved by Ti and Zr additions. The thermal stability of binary V-Ti alloys increases strongly in the temperature range from 600 to 800°C with the Ti content. Ternary Nb additions show an additional stability increase and mask the influence of the Ti. The highest long-term stability was obtained with Ti contents <3%. With increasing Ti content the stability decreases. The effect of the Nb content was lower with increasing time. Neutron irradiation at 50 to 100°C leads in the temperature range from 600 to 750°C not a radiation embrittlement. Corrosion research in static sodium at 550 to 650°C showed it to be not very corrosive because of the impoverishment in oxygen. Studies in flowing sodium showed that the V-Ti and V-Ti-Nb systems did not possess sufficient stability. Further studies showed that the corrosion behavior of all the alloys studied were improved by the addition of Cr and/or Mo. The thermal conductivity of V-Ti alloys increases with the temperature and is at least equal to or higher than that of high-temperature-stable Ni alloys and austenitic steels. The specifications of a canning and construction material for sodium-cooled fast breeders were fulfilled by the V-Ti-Nb alloys with the exception of the corrosion behavior in flowing sodium. (tr-auth)

10001 (KFK-1054) PROBLEMS OF ISOTHERMAL STEAM CORROSION OF INCOLOY 800 ALLOYS IN RELATION TO SURFACE TREATMENT. Leistikow, S.; Pott, E.; Berg, H. v. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Material- und Festkoerperforschung). Jul 1969. 46p. (In German). Dep. CFSTI (U. S. Sales Only).

The influence of various surface treatments on the isothermal steam corrosion of Incoloy Alloy 800 sheet specimens was tested by semidynamic loop experiments at 620°C and 1 atm during 5000 to 10,000 hours. The experiments were evaluated by gravimetric measurements, electromicroscopic and metallographic methods, chemical analysis of steam condensate, oxide scale, and diffusion zone composition. The good corrosion resistance of Incoloy Alloy 800 is based on the protective character and mechanical stability of the oxide scale which is formed on pickled (as received) and electropolished specimens during the first 1000 hours of exposure as a thick, adherent, and non-steam soluble layer. During longer exposure the oxide growth rate slows down and can be approximated by a linear rate law. The multiphase oxide structure and composition was analyzed. The good corrosion resistance can even be improved by cold working of the metallic surface. Compared with long time exposure of the pickled and electropolished condition, ground specimens exhibit only a metal loss after descaling of about 10%. During the first 1000 hours thin oxide scales, rich in chromium, manganese, and other relative unnoble elements are formed. They lose mostly chromium(III)-oxide, oxidized to chromium(VI)-oxide, to the steam system. For longer exposures the extent of metal corrosion, reduced by cold working, can be approximated by a linear function of lower rate. While the linear rate constants of metal oxidation and metal loss-to-system are nearly equal the small oxide scale thickness remains constant and maintains its protective character. (auth)

10002 (MSAR-69-207) EFFECT OF HIGH-TEMPERATURE SODIUM ON THE MECHANICAL PROPERTIES OF CANDIDATE ALLOYS FOR THE LMFBR PROGRAM. Quarterly Progress Report, July-September 1969. (MSA Research Corp., Evans City, Pa.). Nov 1969. Contract AT(11-1)-765. 76p. Dep. CFSTI.

The creep-rupture testing of 304 and 316 ss specimens under the Loop 3 operating conditions [low oxygen (<10 ppM); flow velocity across the specimens of 20 ft/sec; and a system ΔT of greater than 70°F] continued throughout the report period. All tests of 60 mil specimens scheduled in the Work Statement were completed. Test data are currently being analyzed through the use of appropriate mathematical relations and computerized programs for ease in extrapolating to areas beyond those covered by the test program. Specimens from a 10,000-hour exposure were removed from the retort, tensile tested in air, and creep-rupture tested under the clean sodium conditions of Loop 3. These data are reported and are being further analyzed for inclusion in future reports. The exposure of additional 304 and 316 ss specimens is continuing for longer time periods (>10,000 hours). The calibration of three UNC electrochemical oxygen meters with various electrode assemblies has been in progress since June 1968. The operational history of these various electrode assemblies is reported. All work on this project was terminated in September. The most recent studies include the continued calibration of Electrode Assembly TPE-1-252 with an ambient-temperature controller and the testing of Electrode Assembly TPE-1-310 in a high carbon environment. The lack of effect of carbon was noted on the meter. The carbon-oxygen synergistic excursion limited the operation of the carbon meter to monitoring the carbon-activity level. Additional calibration data were not obtainable because of the constant carbon level necessary for the excursion and the operational tests of the UNC oxygen meter in the high carbon loop. The least-squares-calibration curve was updated to produce the final calibration curve. A calibration curve of 5-mil tabs exposed for 168 hours was also prepared by the least-squares method. The carbon meter was utilized for monitoring carbon levels in the operational tests of the oxygen meter and during a special bypass sampling. (auth)

10003 (TRG-Report-1932) A REVIEW OF THE SODIUM/WATER EXPERIMENTS AT DOUNREAY E. R. E. Bray, J. A. (United Kingdom Atomic Energy Authority, Dounreay (Scotland). Reactor Group). 1969. 30p. (CONF-681132-1). Dep. CFSTI (U. S. Sales Only).

From IAEA Special Study Group on Sodium/Water Reactions, Argonne, Ill.

In order to determine the hazards of a tube failure in a sodium-heated steam generator rig tests were designed to establish the following: changes in pressures and temperatures during a Na/H_2O reaction, and the resultant effect on adjacent water tubes in the test bundle and on the main pressure vessel; corrosion/erosion effects on the steels; problems of clean-up and maintenance, and of methods of dealing with gaseous effluent from the reaction. One test rig was used for scale model tests, short length full size pressurized tube tests, and corrosion/erosion tests. Full size full length pressurized tube tests are continuing in a larger rig. It is concluded that tube failures are probably due to severe corrosion/erosion effects on tubes near the reaction zone, and a high local reaction temperature coupled with the high water system pressures. (UK)

10004 MOLTEN METAL-WATER EXPLOSIONS. Flory, K.; Paoli, R.; Mesler, R. (Univ. of Kansas, Lawrence). Chem. Eng. Progr.; 65: No. 12, 50-4(Dec 1969).

Experiments were conducted the results of which strongly support the liquid entrainment theory of molten metal-water reactions. Encapsulation of small quantities of quench liquid inside a drop of molten metal is the proposed mechanism. These experiments also gave results that are incompatible with the other theories put forth. The Helmholtz instability entrapment mechanism offers one possible mechanism for encapsulation of quench liquid. (auth)

10005 INVESTIGATIONS ON INTERNALLY OXIDIZED SILVER ALLOYS WITH SMALL CONCENTRATIONS OF RARE EARTH METALS. Elssner, Gerhard; Gebhardt, Erich (Max-Planck-Institut fuer Metallforschung, Stuttgart). Z. Metallk.; 60: 922-9(Dec 1969). (In German).

The internal oxidation of silver alloys with small concentrations of dissolved Ho is found to be a diffusion controlled process obeying a parabolic rate law. The effects of time, oxygen pressure concentration and temperature on the subscale growth were investigated. The experimentally measured kinetics are nearly in agreement with the equation of Wagner for the constant of internal oxidation k_p. It is assumed that differences between measured and theoretically calculated values are due to the stoichiometric factor v. The deviation from theory seems to result from the temperature dependence of v. Internal oxidation zones are also formed in dilute Ag alloys with small contents of Y, Ga, and Er. In oxygen-treated dilute Ag-La and Ag-Ce alloys no subscales were detected. Only near the melting point did internally oxidized and cold deformed samples of Ag-Ho, Ag-Er and Ag-Y alloys show

a sharp decrease in hardness by annealing in air. By isothermal annealing in hydrogen, internally oxidized and deformed samples were softened even at relatively low temperatures and short annealing times and a coarsening of the oxide particles was observed. On the other hand, samples similarly annealed in air exhibited no decrease in hardness. The stability of the oxide dispersion seems to be a function of the amount of solute metal atoms remaining in the matrix which in turn is controlled by the solubility product of the precipitated oxide and by the concentration of dissolved oxygen. (auth)

10006 DESCALING OF VERY TENACIOUS OXIDE FILM ON STAINLESS STEELS (SAMPLING METHOD USED ON SUPERHEAT TEST ELEMENTS). Edwall, B.; Arvesen, J. (Aktiebolaget Atomenergi, Studsvik, Sweden). Corros. Sci.; 9: 915-16(Dec 1969).

The descaling method described has been used for sampling of oxides formed on superheat test fuel elements with a canning of 20 Cr, 35 Ni–Fe (Incoloy). The oxides are reduced with Li metal formed by electrolysis of LiCl in water-free dimethyl formamide as solvent. The fine metallic powder formed from the reduced oxide is removed on a cotton swab moistened with a weak acid or water. Compared with other electropolishing or etching methods used for descaling, the method described is very rapid, well suited for hot-cell work, and does not interfere with the base metal. (auth) (UK)

10007 INFLUENCE OF GAS PRESSURE ON THE LONG-TERM OXIDATION BEHAVIOUR OF MILD AND LOW-ALLOY STEELS IN CARBON DIOXIDE ATMOSPHERES AT 350 TO 450°C. Goodison, D.; Harris, R. J.; Goldenbaum, P. (British Nuclear Design and Construction Ltd., Whetstone, Eng.). Brit. Corros. J.; 4: 293-300(Nov 1969).

Long-term oxidation tests of mild and low-alloy steels in CO_2 atmospheres containing minor quantities of CO and moisture show that as the gas pressure increases from 0–600 psi, there is a decrease in the time to breakaway and possibly an increase in the post-breakaway oxidation rate. If the partial pressure of the moisture in the gas it kept constant, then the post-breakaway rate may be constant from 200–600 psi though there is an increased initial rate of development of excrescences. At 600 psi, breakaway may occur in the absence of moisture and Co at 450° but may not occur at 350° even with significant quantities of both present. The form of the oxidation/time relationship is shown to depend on the initiation and development of excrescences. An attempt has been made to categorise the major types of excrescences observed. (auth) (UK)

10008 STRESS-CORROSION SUSCEPTIBILITY OF TITANIUM ALLOYS IN AQUEOUS ENVIRONMENT. Mackay, T. L.; Tiner, N. A. (McDonnell Douglas Astronautics Co., Newport Beach, Calif.). Metals Eng. Quart.; 9: No. 4, 59-60(Nov 1969).

In regard to the susceptibility of alpha-beta titanium alloys to stress-corrosion cracking (SCC) several things are noted. The hydrogen content of titanium alloys did not appear to influence SCC. If hydrogen ions in aqueous environment were playing a role, it was limited to influencing the electrochemical reaction which may occur on a monolayer of adsorbed titanium halide at the surface of the crack tip. Increasing aluminum content (above 5%) in titanium alloys appeared to increase the susceptibility to SCC in aqueous environment. The effect was not completely associated with ordering reactions but appeared also to be related to lowering of the stacking fault energy and to the formation of planar groups of dislocation arrays with low resistance to transgranular failure. The nonequilibrium acicular martensitic structures have high fracture toughness and superior resistance to stress-corrosion cracking. The restricted deformation of the martensitic alpha phase by retained beta appeared to be associated with immunity to SCC and lowering of the beta stabilizer (Mo, V, or Cb) appeared to increase the susceptibility to SCC. (auth)

10009 KNIFE-BLADE CORROSION IN WELDED JOINTS OF INCOLOY 825 (FORMERLY Ni–O–Nel 825). Bernabai, U. (Univ., Rome); de Gregorio, G. Com. Naz. Energ. Nucl., Notiz.; 15: No. 11, 37-51(Nov 1969). (In Italian).

The results are given of corrosion tests (boiling HNO_3, 13 M HNO_3, 0.04 M NaF and 0.1 M $Al(NO_3)_3$ solutions) of samples from welded joints and sheets of Incoloy 825, C = 0.05% alloy, proposed for and used in highly corrosive environments, and in particular for fuel processing plant components. (auth)

10010 KINETICS OF THE FORMATION OF OXIDE FILMS ON METALS. Cismaru, D.; Simon, Z. (Inst. of Chemical Physics, Bucharest). Rev. Roum. Chim.; 14: 837-43(Jul 1969). (In Rumanian).

The kinetics of oxidation reactions of several metals (Th, Tl, Mg) were calculated by means of the Eyring theory on the absolute speed of reaction. The results conform with theoretical predictions and follow a linear oxidation law. (tr-auth)

10011 TREATMENT OF ZIRCONIUM–NIOBIUM ALLOY. Boxall, Douglas G. (to Canadian General Electric Co. Ltd.). British Patent 1,177,218. 7 Jan 1970. Filed 16 Dec 1966.

Reference is made to the treatment of Zr–Nb alloy components, such as fuel channels for water reactors, with a view to increasing corrosion resistance. The process described comprises quenching the solution treated component from a temperature in the range 850 to 950°C, heavily cold working the component, and aging within the reactor under service conditions. The cold working may comprise drawing through a die to effect cold working up to 50%. In the case of a tube the cold working may be effected by roll swaging. (UK)

Preparation and Fabrication

Refer also to abstract 9624.

10012 (BNWL–311) PREPARATION OF NEPTUNIUM–ALUMINUM ALLOY TARGET ELEMENTS. Bloomster, C. H. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Oct 1966. Contract AT(45-1)-1830. 14p. Dep. CFSTI.

A casting process was developed to fabricate neptunium target elements for irradiation in N-Reactor. Forty-nine targets were fabricated for a ^{238}Pu demonstration program. Aluminum–neptunium alloys were prepared by reducing neptunium oxide with aluminum under a cryolite flux. The Al–Np alloy was cast into tubes by use of graphite mandrels and molds. The tubes were machined to specified lengths and diameters, and inserted into aluminum can assemblies which, in turn, were inserted into zirconium cans. Process yields were excellent. Scrap from rejected castings, machining chips, and the one rejected element was recovered by remelting. Overall, 5.0 Kg of neptunium entered the process; 4.3 kg neptunium went into the targets; and 0.7 kg of neptunium scrap was left for recovery at the end of the fabrication. (auth)

10013 (GEMP–1012(Pt.1), pp 263-382) FAST BREEDER REACTOR ADVANCED FUEL ELEMENT CLADDING FABRICATION. Frank, R. G.; Tarr, C. O. (General Electric Co., Cincinnati, Ohio. Nuclear Systems Programs).

The development of processing techniques for the production of ductile, high-purity molybdenum tubing in support of the FBR advanced fuel element cladding program was continued. Studies pertained to the effect of processing variables on mechanical properties, product quality, and cost. Previous work had demonstrated that porosity free welds could be made consistently in molybdenum sheet which was produced by powder-metallurgy processes that included purification of the powders. The ductile-brittle bend transition temperature of the welded sheet is less than –50°C. The purification process consists of leaching the powders in 0.012 M HCl or 0.014 M HNO_3 acid solutions to remove tramp impurity elements and treating the pressed compact in wet hydrogen (5°C dewpoint) for 500 hours at 1000°C followed by 150 hours in dry hydrogen to remove carbon and oxygen impurities to less than 5 and 10 ppM, respectively. Recrystallization studies and creep tests at 1200 and 2200°C showed that the recrystallization temperature of the GE-NSP-purified molybdenum is lower than the recrystallization temperature of commercial powder-metallurgy molybdenum for a given set of conditions and that the creep rates of NSP-purified molybdenum are significantly higher than the corresponding creep rates for commercial powder-metallurgy molybdenum. These data further substantiate the effectiveness of the purification treatments in removing impurity elements from molybdenum. Studies to reduce the cost of the purification process for molybdenum as well as reduce the equipment utilization time showed that treating of loose powders at temperatures as low as 800°C and for times as short as 2 to 4 hours is effective in reducing the carbon content to a level of less than 5 ppM. It was also found that an adsorbed film containing 10 to 20 ppM carbon can form on molybdenum powders exposed to the atmosphere within a period of 24 hours. Therefore, it is necessary to seal purified powders in argon-filled containers for storage. Processing procedures for producing FBR size fuel clad tubing were established with commercial arc-cast molybdenum tube blanks and included two levels of carbon, 10 and 40 ppM. The process variables studied included the initial structure (fibrous, partially recrystallized, and fully recrystallized), amount of reduction between in-process anneals (33, 50, and 75%), in-process annealing temperature (stress relief and recrystallization), and final stress relief temperature (900 to 1150°C). The objective of the thermal-mechanical study is to identify an economical processing sequence that will obtain the best combination of strength

and ductility at ambient temperature and at the FBR operational temperature range of 550 to 750°C and to correlate the attained properties with the microstructure and texture of the finished tubing. Processing procedures were developed for producing thermocouple sheaths and thermoelements. Initially, seamless thermocouple sheaths were processed to 0.157-cm OD by 0.0191-cm wall from W-25Re and W-25Re-30Mo alloy blanks produced by GE-NSP and from unalloyed rhenium purchased from a commercial vendor. Because of unsatisfactory quality of the sintered rhenium draw stock the reworked rhenium tubes were not assembled into thermocouples. Also, it was found that the relatively high vapor pressure of molybdenum made the W-25Re-30Mo alloy unacceptable for thermocouple applications where long exposures at 2300 to 2800°C are expected. A number of tubes were produced to demonstrate the feasibility of mandrel drawing in the small size range required for thermocouple sheaths. Three of the W-25Re alloy mandrel-drawn tubes were included in a thermocouple assembly contained in a mixed oxide (PuO_2-UO_2) capsule for testing at 2600°C (simulated centerline temperature). Work currently is in progress to produce W-25Re alloy seamless tubes of 0.157-cm diameter in lengths of 46 to 80 cm. Based on previous refractory metal wire fabrication technology in which 0.0087-cm diameter W-0.5 Os and W-1.0 Os alloy thermocouple wire was produced for the first time, improved processing techniques were developed to improve the material yield of W-0.5 Os alloy wire. Four meters of 0.05-cm-diameter wire W-0.5 Os alloy were processed. Process development work continued to produce high-quality, ductile tungsten alloy tubing in various sizes. Tubing 1.308-cm, 1.245-cm, and 0.439-cm OD; sheet 0.028 to 0.050 cm thick; and rod 1.254-cm diameter of W-30Re-30Mo alloy and W-25Re alloy were produced. Process procedures were developed for producing T-111 alloy/W and T-111/Mo composite tubing for use as fuel element cladding in lithium-cooled, advanced space power reactors. The tungsten liner can be formed from multi-layers of 0.00254-cm-thick foil; metallurgical bonding of the tungsten to itself and to the T-111 alloy is achieved through the hot-gas pressure bonding techniques at 1650 to 1750°C and pressures of 700 kg/cm^2. The T-111/W composite tube is representative of numerous material combinations which could be produced for any specific application requiring compatibility with two different environments. (auth)

10014 (KFK-985, pp 249-54) HEAT TREATMENT OF A 15/15 Cr-Ni STEEL FOR USE AS CANNING MATERIAL. Egnell, Lennart (Sandvik Steel Works, Sadviken (Sweden)). (In German).

The effect of various heat treatments on the time stability properties of a 15/15 Cr-Ni steel was investigated. The results showed that two treatments yield good properties: quench annealing at high temperatures or annealing at about 800°C after a 10 to 15% cold deformation. The latter treatment gives the most suitable state to counteract a high temperature embrittlement and to show a high time stability. (J.S.R.)

10015 (LFEN-NI-37-a) PROBLEMS IN SOLDERING THE REFRACTORY METALS, NIOBIUM, MOLYBDENUM, TANTALUM, AND TUNGSTEN. Carvalhinhos, H. (Junta de Energia Nuclear, Sacavem (Portugal). Laboratorio de Fisica e Engenharia Nucleares). 1968. 30p. (In Portuguese). Dep. CFSTI (U. S. Sales Only).

The problems in the soldering of the refractory metals Nb, Mo, Ta, and W are summarized in a bibliographic review. The effect of alloying elements on the soidering is first considered. The specific problems encountered in arc welding under an inert gas, electron welding, resistance welding, brazing, and laser welding are outlined. The problems of contamination, effects of the order of magnitude on the ductility of the welds, and the effects of aging and over-aging were especially considered in arc welding. (J.S.R.)

10016 (ORNL-4463, pp 1-9) PROGRAM ADMINISTRATION AND PROCUREMENT. (Oak Ridge National Lab., Tenn.).

From Heavy-Section Steel Technology Program.

The thirteen research and development investigations sponsored by the Heavy-Section Steel Technology (HSST) program for assessing the structural safety of present and contemplated water-cooled reactor pressure vessels and the agencies responsible for these investigations are discussed. The major material procurement has been completed with the exception of the 10-in.-thick ASTM A543 plate and the 6-in.-thick weldments for dynamic-tear and tensile testing. Step-by-step procedures are enumerated for the fabrication of the 10-in.-thick plate and for making stick-electrode and submerged-arc welds. (L.C.L.)

10017 (RFP-1333) GAS-METAL ARC BRAZE WELDING OF INGOT-SHEET BERYLLIUM. Merlini, Richard J.; Bush, Walter L. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). 22 Oct 1969. Contract AT(29-1)-1106. 13p. Dep. CFSTI.

Discussed are studies on the Gas-Metal Arc welding of ingot-sheet beryllium produced at Rocky Flats. The results of a weld-porosity study indicated that radiographically porous-free welds could be made if the proper welding process parameters were used. Tensile-test data of welds showed that welds stronger than the base metal were easily produced if unbonding was avoided. The results of specimens tested for weld unbonding confirmed previous data from hot-pressed beryllium that a fill factor of less than 10 must be used to prevent unbonding between the weld and the base metal. Graphs showing general process-parameter limits have also been constructed and are presented. (auth)

10018 (SRO-475-4) POWDER METALLURGY COMPACTION. Quarterly Progress Report, 1 September-30 November 1969. Schwartz, E. G.; Goodwin, Lewis R.; Wilson, Kenneth L.; Hornsby, James B. (South Carolina Univ., Columbia. Coll. of Engineering). Contract AT(38-1)-475. 21p. Dep. CFSTI.

The feasibility of using porous die liners as a means of providing die wall lubrication in powder metallurgy compaction was evaluated. More specifically, a new lubricant, butyl stearate, which has flow properties in the porous die liners slightly superior to previously tested lubricants was studied. Continuous high pressure lubrication was also evaluated and compared with the intermittent lubricating procedure used previously. Further investigation was initiated in the area of die translation. Two methods are being considered; slow vertical translation during compaction, and vibration of the die during compaction. Presently the apparatus has been designed, orders placed for the required equipment, and modification work on existing equipment has begun. A continuing program of lubrication evaluation is underway. As new lubricants come to light they are tested and compared with previous lubrication data. The lubrication evaluation area also includes methods of application. Work underway to develop a method of application which will control the lubricant film thickness is described. (auth)

10019 THE PREPARATION OF SPECIMENS OF VANADIUM AND VANADIUM ALLOYS FOR OPTICAL AND ELECTRON MICROSCOPY. Boelsing, Renate; Braun, Egon; Heubner, Ulrich; Ruehle, Manfred (Metallgesellschaft AG., Frankfurt am Main). Prakt. Metallog.; 6: 475-83(Aug 1969). (In German and English).

The etch-figure technique represents a valuable supplement to other methods for the determination of crystallographic orientations, in particular when comparing single, immediately neighboring grains or investigating specimens with large grain diameters. Especially for the removal of cube faces methods are described concerning a quantitative determination of both the sectioning planes of grains with respect to crystal co-ordinate system and the crystal orientation with respect to any reference co-ordinate system, the latter in order to design pole figures. The geometric relations inherent in the etch figures and necessary for their evaluation are derived and explained by examples. (auth)

10020 PYROLYTIC TUNGSTEN (REVIEW OF THE LITERATURE AND THERMODYNAMICS OF THE PRODUCTION PROCESS). Emyashev, A. V.; Slavgorodskaya, Z. V. Konstr. Mater. Osn. Grafita; No. 3, 84-9(1967). (In Russian).

Known reactions are examined for obtaining pyrolytic tungsten from the gas vapor phase. These indicated the advantages of film produced by hydrogen reduction of W hexafluoride (high purity, rapidity, and lack of interaction with graphite). Thermodynamic calculations are given for reactions which produce pyrolytic W from its halogen compounds in order to establish the lowest possible equilibrium temperatures for useful experimentation. A method was found to establish optimal temperatures in order to insure the required speed in production processes. (JPRS)

10021 FUNDAMENTALS OF ARC AND PLASMA SPRAYING IN PROTECTIVE ATMOSPHERE CHAMBERS. Steffens, H.-D.; Kayser, H. Metalloberflaeche; 23: 175-9(Jun 1969). (In German).

The design criteria for inert-gas chambers for metal spraying are discussed. High-quality, homogeneous metal coatings can be produced by this new technique. The cost is too high for mild steel articles, but can be justified for small runs of special steels and other metals (e.g., W and Mo components). (Metals Abstr.)

10022 GENERAL REQUIREMENTS IN THE FABRICATION OF STAINLESS AND CARBON STEELS AND HEAT TREATMENT FOR THE PREVENTION OF INTERCRYSTALLINE CORROSION. Huizing, R. (Gemeenschappelijke Kernenergiecentrale Nederland, Arnhem). Lastechniek; 34: 132-5(May 1968). (In Dutch).

The control and inspection operations necessary to guarantee the delivery of quality apparatus are briefly summarized. The appearance of intercrystalline corrosion during the welding and heat processing of stainless steel is described on the basis of

specific examples. An example is given of the specifications for heat treatment of stainless steel. (tr-auth)

10023 FORMING WELDS OF EDGES AND TUBES OF THICK-WALLED PRESSURE VESSELS. Weeber, P. G. Lastechniek; 34: 143-5(May 1968). (In Dutch).

Forming welds are defined and their characteristics are given. The applicability is indicated and the welding methods available are summarized. The selection of the materials and the mechanical properties and chemical composition of the welds are tabulated. (J.S.R.)

10024 AN EXPERIMENTAL STUDY ON THE ELECTRO-POLISHING OF METALS. Shenoi, B. A.; Indira, K. S. Electroplat. Metal Finish.; 22: No. 6, 19-23(1969).

A study of the electropolishing of metals and alloys, using aqueous and non-aqueous electropolishing baths, is reported. Bath compositions and operating conditions for polishing Al, Bi, Cd, Cr, Co, Cu, Au, In, Pb, Mg, Ni, Ag, Ta, Sn, Ti, W, Zn, stainless steel, and brasses, are given. Optimum conditions for electropolishing are discussed. A comparison of factors responsible for polishing is made and the properties of the surfaces are discussed. General features of perchloric acid and phosphoric acid type electrolytes are considered. In many aqueous solutions viscosity controls the film formation. (Metals Abstr.)

10025 IN-PROCESS CONTROL OF RESIDUAL STRESS IN DRAWN TUBING. Misra, S. K. (Continental Can Co., Chicago); Polakowski, N. H. J. Basic Eng.; 91: 810-15(Dec 1969).

Experimental work directed toward the development of means for in-process control of residual stress during tube drawing is described. Experiments were done on 304 and 321 stainless steels, Incoloy 800, and copper tubing. While classical tube reducing processes, such as mandrel and plug drawing and sinking were the main objective, limited data on the effects of reeling and rock-rolling were also included. The distribution of residual axial and hoop stresses across the wall was determined by a Sachs' analysis. Tandem drawing, wherein a small reduction (~2 percent) was taken in the second die, produced a drastic reduction of the residual stress levels. A tapered bearing exit-die was specially efficient in this respect. However, the method was inefficient in pure sinking which always left residual stresses of high magnitude. (auth)

10026 CAST STEEL TUBE BENDS FOR THE PRIMARY CIRCUIT OF PRESSURIZED WATER REACTORS. del Villar, A. Sulzer Tech. Rev.; 51: 63-4(1969).

The fabrication of austenitic cast steel tube bends for the primary circuit of pressurized-water reactors is discussed as to quality requirements, material composition, and casting and welding procedures. (L.C.L.)

10027 PREPARATION AND PROPERTIES OF NIOBIUM–TIN DIFFUSION STRIPS. Alekseevskii, N. E.; Glasnik, I.; Dubrovin, A. V.; Kruzhlyak, Ya.; Mikhailov, N. N.; Sokolov, V. I.; Smirnova, M. N.; Fedotov, L. N. Izv. Akad. Nauk SSSR, Metal.; No. 5, 215-23(Sep-Oct 1969). (In Russian).

The diffusion method allows difficulties to be by-passed in the production of flexible conductors of Nb_3Sn. The manufactured forms of this superconductor have satisfactory mechanical properties and high critical parameters. These strips are convenient for the production of coils of magnetic systems due to their high flexibility. (M.C.G.)

10028 INVESTIGATION OF THE STRUCTURE AND PROPERTIES OF GRANULATED ALUMINUM ALLOYS WITH REFRACTORY METALS. Dobatkin, V. I.; Elagin, V. I.; Fedorov, V. M. Izv. Akad. Nauk SSSR, Metal.; No. 5, 164-9(Sep-Oct 1969). (In Russian).

It was established that on crystallization in granules, anomalously supersaturated solid solutions of aluminum with up to 4.5 to 5% Mn, 1.5 to 2% Cr, 1.5 to 2% Zr, 1 to 1.2% V, or 1 to 1.2% Ti are formed. (M.C.G.)

10029 METHOD FOR THE FABRICATION OF FUEL ELEMENTS FOR NUCLEAR REACTOR. (to Belgonucleaire Societe Belge pour l'Industrie Nucleaire Societe Anonyme). British Patent 1,177,734. 14 Jan 1970. Priority date 5 May 1967, Germany.

A method is given for the fabrication of uranium 235-enriched nuclear fuel elements. The fuel particles are of three sizes and vary in uranium-235 enrichment, the largest particles have a uranium-235 content less than the average uranium-235 content of the fuel. The proportion of large particles in the complete mixture of particles is the greatest that can be accommodated in the canning. The enrichment and the size of the intermediate and small particles vary along the length of the fuel element. The vibratory compaction method was used to fill the tubular fuel element in order to obtain high density. (J.C.W.)

10030 ACTIVATION OF THE PROCESS OF TUNGSTEN SINTERING WITH METALS OF IRON GROUP. Samsonov, G. V.; Yakovlev, V. I. (Inst. of Problems of Material Management, Kiev). Porosh. Met., Akad. Nauk Ukr. SSR; No. 10, 32-8(Oct 1969). (In Russian).

The effect of metal additives of the iron group on the sintering ability of tungsten powder was investigated at 1000 to 2000°C. It was shown that the activating effect of additives increased in the direction Fe → Co → Ni. The method of the additive introduction did not affect the process of tungsten powder sintering. An explanation of the mechanism of activated sintering of tungsten is suggested on the basis of a configuration localization model of the atom valence electrons. (auth)

10031 CHANGE OF COMPACTNESS AND STRUCTURE OF SINTERED TUNGSTEN BLANKS DURING THEIR SURFACE FUSION. Zhudinov, M. I. (Scientific-Research Inst. of Machine-Building Tech., Leningrad). Porosh. Met., Akad. Nauk Ukr. SSR; No. 10, 52-4(Oct 1969). (In Russian).

The sintering of tungsten briquettes in an electronic-beam installation under the conditions of heating and surface fusion is described. It is shown that blanks with an average compactness of about 175 g/cm^3 can be obtained by this method in a short period of time. (auth)

10032 TUNGSTEN NEWS, DECEMBER 1969. Tungsten News; 1-18(1969).

The properties and uses of tungsten are reviewed. The strengthening mechanism in nickel-base superalloys with tungsten and molybdenum added simultaneously is a current trend. The properties of tungsten make it desirable for use in motor vehicle ignition systems. Research on tungsten coatings is also reported. Naturally occurring ^{184}W has been found to be a useful dosimeter for thermal neutrons in high-temperature irradiation. The (110) plane of tungsten crystals is being used for thermionic converter surfaces. The use of coatings on tungsten carbide tools and other advancements in the tool business are discussed. Tungsten carbide studded tires are being tested. New applications of tungsten-base alloys are given. New recovery methods for tungsten are discussed and methods for determining tungsten content in ores are described. Research on tungsten oxides, zirconium tungstate, tungsten selenides, tungsten disilicides, tungsten borides, and tungsten fluorides is reported. A listing of 242 references is given. (J.C.W.)

Properties Evaluations

Refer also to abstracts 10493, 10619, and 11210.

10033 (BNL-50204) HIGH-TEMPERATURE LIQUID-METAL TECHNOLOGY REVIEW. A Bimonthly Technical Progress Review, Volume 7, Number 4. (Brookhaven National Lab., Upton, N. Y.). Aug 1969. 159p. Dep. CFSTI.

All phases of high-temperature liquid-metal technology, including materials development, corrosion and mass transfer, heat transfer, fluid dynamics, instrumentation, purification, component development, physical properties, thermodynamics, chemical analysis, and power systems are covered. Up-to-date information on the various research and development programs in the United States is summarized. A list of reports issued in Europe in this field is appended. (J.C.W.)

10034 (BNWL-1200-1, pp 2.1-20) SODIUM SYSTEM CHEMISTRY. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Design and planning for the Sodium Chemical Technology Facility (SCTF) was continued, but because of schedule and funding problems, it may not be possible to locate the SCTF in the 190FA Building as planned. A review of alternate facilities showed that the recently completed 335 Building is a feasible location. A conceptual design of the SCTF in the 335 Building has been prepared, and the cost estimates, project proposal, and design criteria have been revised. The water hydraulic mockup flow tests of the SCTF vessel were completed. These hydraulic tests showed that a two-jet mixing system powered by an EM pump could achieve complete mixing of the SCTF vessel in less than one minute. Field testing of oxygen and carbon meters continued. Tests of the carbon meter showed no meter response to exposure of NaCN, Na_2CO_3, a graphite rod, or methane in the cover gas with 600°F sodium. However, the meter did respond rapidly to a source of Na_2C_2 at 600°F; the carbon flux increased as the sodium flow past the Na_2C_2 injection tube increased. (auth)

10035 (BNWL-1200-1, pp 3.1-58) SODIUM COOLANT STUDIES. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

The sodium coolant studies work was directed at the FFTF primary and closed loop recovery from deleterious effects of radioactive corrosion products and fuel failures. Circumstances that define recovery needs are to be identified, recovery methods are to be developed and proven, and operating limits to assure successful recovery are to be determined. A model which defines fuel failure modes, significant physical and transport properties of released materials, and the couplings between failure mode and contamination behavior was developed. Data on long-term changes in the condition of materials in sodium systems are indicative of ferrite formation in the loop hot leg. The data also indicate mass transport and intergranular attack. Studies of corrosion product transport in small thermal convection loops indicated that release mechanisms differ for the various constituents of stainless steels. Test results in a small sodium loop suggested preferential deposition of fission products in regions with flow perturbations. A study was made of carbon transport and air-side oxidation in an FTR Secondary System design concept. This concept is based on fabricating the system from a combination of 304 stainless steel and Croloy. Results indicated the steel would carburize to a depth of 8 ± 3 mils in the design lifetime of 20 years. Air-side oxidation could reduce Croloy thicknesses by 20% or more in the same time period. Study of possible alternative methods for removing fuel particles released by fuel failures in the FFTF closed loops led to selection of a reference concept, of an in-line vortex generator on the reactor outlet piping. Studies to select an effective decontamination agent for FFTF have been initiated. The argon-moist air process was selected as the reference concept for removing sodium from fuel subassemblies that are to be examined nondestructively. A study was made to determine what information would be needed to assure that testing will be properly prototypical of the FFTF system. Problem areas associated with water-system prototype testing were defined, and studies to resolve them have been started. Design of the water system mockup has begun. (J.R.D.)

10036 (EURFNR-627) SODIUM PROPERTY DATA. Pee, A. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Reaktorentwicklung). Translation of report KFK-924. 86p. Dep. CFSTI.

Work performed under United States-Euratom Fast Reactor Exchange Program.

This paper was abstracted from the original language and appeared in NSA as 23: 36070. (G.M.C.)

10037 (GA-9495) SOME INVESTIGATIONS OF REFRACTORY METAL SYSTEMS OF THERMIONIC INTEREST. Hudson, R. G.; Horner, M. H.; Yang, L. (Gulf General Atomic, Inc., San Diego, Calif.). Nov 1969. Contract AT(04-3)-167. 14p. (CONF-691024-2). Dep. CFSTI.

From IEEE Thermionic Conversion Specialist Conference, Carmel, Calif.

Interdiffusion of the W-Ta, W-Mo, and W-Nb systems was studied in the temperature range 2000 to 2200°C. The diffusion rate was found to be in the order of W-Ta < W-Mo < W-Nb. For a diffusion time of 100 hours, the widths of the diffusion zone deduced from the concentration distribution curves of the samples studied were: (1) 2000°C - 39, 88 and 130 microns; (2) 2100°C - 77, 118 and 301 microns; and (3) 2200°C - 134, 164 and 486 microns; for the W-Ta, W-Mo, and W-Nb systems, respectively. In all the cases studied, the concentration distribution curves were unsymmetrical with respect to the Matano interface, and the diffusion constants deduced from these curves by using the Boltzmann-Matano method increased with the increase of the Ta, Mo, or Nb concentration. Kirkendall voids were observed on the Ta, Mo, or Nb side of the interface in systems studied at 2000°C, but very few or no voids were found in systems studied at 2200°C. Pre-treatment at 2200°C for 100 hours was found to reduce the number of Kirkendall voids formed at a W-Ta interface upon subsequent heating at 1650°C for 400 hours. Planar emitter structures were prepared by diffusion bonding W emitters of 40 mil thickness to Ta-10W substrates. After these emitter structures were operated in cesiated converters at 1427 to 1575°C for 2000 to 4000 hours, their vacuum work functions were measured and then the widths of the diffusion zones at the W to Ta-10W interfaces were determined. The diffusion zones varied from 30 to 80 microns in thickness. There was no indication that their vacuum work functions were affected by such interdiffusion. Measurements were made on the vacuum work functions of W-2Mo, W-5Re, and W-25Re alloys at 1800°C. The W-2Mo alloy emitted essentially like Mo with a vacuum work function of 4.39 eV. The W-5Re alloy yielded a vacuum work function of 4.69 eV. The W-25Re alloy had a slight (110) preferred orientation and yielded a vacuum work function of 4.77 eV. (auth)

10038 (GEAP-5726) INFLUENCE OF STRESS/STRAIN CONCENTRATION AND MEAN STRESS ON THE LOW-CYCLE FATIGUE BEHAVIOR OF THREE STRUCTURAL STEELS AT ROOM TEMPERATURE. Krempl, E. (General Electric Co., Schenectady, N. Y. Materials and Processes Lab. General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Sep 1968. Contract AT(04-3)-189. 36p. Dep. CFSTI.

The influence of stress/strain concentration and mean stress on the low-cycle fatigue behavior (100 to 50,000 cycles-to-failure) at room temperature was determined for three low-strength steels: low carbon steel, 2-¼ Cr-1 Mo alloy steel, and Type-304 stainless steel. Circumferentially grooved cylinders with a uniaxial theoretical elastic stress concentration factor of $K_t \approx 3$ were tested under zero nominal mean stress and a nominal mean stress equivalent to the stress amplitude. In each case, load control was used. High elongation foil strain gages of $^1/_{16}$-in. and $^1/_{32}$-in. gage length measured cyclic plastic strains in the root of the notch in the axial and circumferential directions. The smooth-bar, completely reversed, strain-controlled, low-cycle fatigue behavior was also determined. The influence of a nominal mean stress on the deformation behavior in the root of the notch is shown. At a given nominal stress range, the strain range in the root of the notch is considerably less for the zero-to-tension loading than for the completely reversed loading. At low nominal stresses, no appreciable change in notch-root strain range with cycling can be observed. At high nominal stresses, which lead to total notch-root strain ranges above 1.4%, a decrease in the notch-root strain range is observed with cycling. This observation corresponds to the cyclic strain-hardening behavior of the smooth-bar specimens. A fatigue strength reduction factor was determined for crack initiation, which is defined by the appearance of a 0.005 to 0.015-in.-long crack in the root of the notch. This factor depends on the mean stress, the applied stress range, and the material, and can be considerably higher than the theoretical elastic stress concentration factor. Crack initiation consumes only a small percentage of the specimen life; the rest of the life is consumed by crack growth. It is suggested that design against low-cycle fatigue should use specific analysis tools for each stage of the failure process. The fatigue strength reduction factor can be used to determine crack initiation; crack growth may be calculated by an extension of Fracture Mechanics concepts. (auth)

10039 (GEMP-1012(Pt.1), pp 13-70) PHYSICAL AND MECHANICAL PROPERTIES OF REACTOR MATERIALS. Conway, J. B.; Flagella, P. N. (General Electric Co., Cincinnati, Ohio. Nuclear Systems Programs).

Tensile properties for wrought, arc-cast molybdenum sheet in the stress-relieved and recrystallized conditions were determined at 25 to 1200°C. The ductility, based on elongation (2.54 cm gage length) at fracture, for the 300 to 900°C range was 3 to 5 percent and 40 to 50 percent for the stress-relieved and recrystallized forms, respectively. Creep tests of recrystallized material at 550 to 750°C showed significant strain on loading followed by a low creep rate. This is attributed to the yield point phenomenon observed when tensile tested at these temperatures. A characterization of the tensile and stress-rupture strength at 25 to 2400°C involving rupture data to 10,000 hours is presented. Creep-rupture test of wrought, powder-metallurgy W-25Re-30Mo (at. %) showed no influence of metal-powder purification when tested at 1600°C. Considerable differences were seen when creep-rupture tested at 2200°C. At 1600°C, the stress-rupture life as well as the time to yield 10 percent strain exceeds that for wrought, arc-cast Mo-TZM by an order of magnitude. On the other hand the rupture life for W-25Re exceeds that for W-25Re-30Mo by approximately a factor of five. The effect of thoria additions (0.9 wt %) on the creep-rupture properties for W-30Re-30Mo alloy was investigated at 1600 and 2200°C. The results show that the rupture life is reduced below that obtained for unthoriated material. The creep-rupture properties for wrought, arc-cast W-25Re alloy, previously reported for the range of 1600 to 2600°C, were investigated at 1200°C. At constant load, no primary or secondary creep was noted for the alloy at 1200°C; a behavior also observed at the higher temperatures. Creep-rupture tests of Ta, Nb, and Cb-753 in a vacuum of 1×10^{-6} torr at 1200 and 1600°C showed an increase in oxygen contamination; the amount of oxygen content was a function of the time on test. Values as high as 4,000 ppM oxygen were obtained after testing Cb-753 at 1600°C for 350 hours. The thermophysical properties of 304L stainless steel were measured at 300 to 1375°C; thermal diffusivity and electric resistivity of AISI 316 stainless steel were measured in this same temperature range. These data agreed well with literature values up to 1000°C, the maximum temperature for which data

are reported in the literature. The values at higher temperatures appear to be validated by the correlation between thermal conductivity (from diffusivity) and electric resistivity. The thermal diffusivity of W, Mo, Re, W-25Re, and W-30Re-30Mo, measured previously, are compared with the results of AISI 304L and 316 stainless steels. The enthalpy of UN was measured at 1100 to 2600°C. This is apparently the first enthalpy data published for this material for temperatures above 1200°C. (auth)

10040 (KFK-985, pp 207-21) HIGH-TEMPERATURE-STABLE AUSTENITIC STEELS: CONVENTIONAL PROPERTIES. von den Steinen, Albert (Deutsche Edelstahlwerke A. G., Krefeld (West Germany)). (In German).

Properties of high-temperature-stable austenitic steels were studied. Principally its time stability behavior and the modification of this property by various contents of carbon, nitrogen, and boron, by the presence of niobium or titanium used for stabilization, and by a mechanical-thermal pretreatment were investigated. (tr-auth)

10041 (KFK-985, pp 223-47) DEVELOPMENT OF AUSTENITIC CANNING MATERIALS. Reiff, K. H. (Siemens A. G., Erlangen (West Germany)). (In German).

Extensive out-of-pile studies were made on the development of a canning material relatively insensitive to high temperature radiation embrittlement. The results show that the modifications (16 Cr/13 Ni/Nb) + 50 ppM ^{11}B, (16 Cr/16 Ni/MoNb) + 50 ppM ^{11}B, and 16 Cr/16 Ni/MoNb) without Nb + 0.4% Ti + 50 ppM ^{11}B represent the most promising materials in the unirradiated state with respect to fracture behavior and time stability. (tr-auth)

10042 (KFK-985, pp 255-61) HEAT TREATMENTS AND MICROSTRUCTURE FOR THE OPTIMUM PREIRRADIATION CREEP PROPERTIES OF AUSTENITIC STAINLESS CLADDING MATERIALS WITH ADDITIONS OF Mo, Ti, AND B. Lagneborg, R. (Aktiebolaget Atomenergi, Stockholm (Sweden)).

Data and information are presented on material composition, heat treatment optimization, and creep properties of austenitic stainless steel fuel cladding. (J.R.D.)

10043 (KFK-985, pp 273-87) DISPERSION STRENGTHENED FERRITIC STEELS: A POSSIBLE WAY TO AVOID HIGH TEMPERATURE IRRADIATION EMBRITTLEMENT. Huet, J.-J. (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)).

Methods of obtaining oxide dispersions in steel are discussed. Efforts directed toward production of finer dispersed particles are reported along with research on ways to reduce total stresses in the material. (J.R.D.)

10044 (KFK-985, pp 403-18) PRACTICAL BASIS AND THE TOLERANCES OF A FUEL ROD CAN. Schmidt, G. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Reaktorentwicklung). (In German).

In a discussion of the practical basis and tolerences of a fuel rod can, it is first shown how the construction of the fuel can is in reality a problem of stability and tightness. The boundary conditions to which the can is exposed are outlined. The construction of fuel rod cans for sodium cooling places special specifications on the cans and these are described. The causes of possible ruptures in the can are discussed. A mathematical explanation is given of the tolerances of a fuel rod can, and the effects of bundling are considered. The stresses to which a can is exposed to gas of steam cooled reactors are outlined and mathematically evaluated. The particular questions arising in the assembly of the fuel element are discussed. (J.S.R.)

10045 (ORNL-4463) HEAVY-SECTION STEEL TECHNOLOGY PROGRAM. Semiannual Progress Report for Period Ending February 28, 1969. (Oak Ridge National Lab., Tenn.). Jan 1970. Contract W-7405-eng-26. Dep. CFSTI.

The information in this report is presented in five sections. A separate abstract was prepared for each section. (L.C.L.)

For abstracts of individual sections see: 10016, 10046–10048, and 10123.

10046 (ORNL-4463, pp 10-88) INVESTIGATION OF UNIRRADIATED MATERIALS. (Oak Ridge National Lab., Tenn.).

From Heavy-Section Steel Technology Program.

Studies of unirradiated materials for the Heavy-Section Steel Technology (HSST) program include inspection, characterization, variability determinations, transition temperature investigations, fracture mechanics studies, and fatigue-crack propagation tests. Current work in these areas is discussed. (L.C.L.)

10047 (ORNL-4463, pp 122-36) PRESSURE VESSEL INVESTIGATIONS. (Oak Ridge National Lab., Tenn.).

From Heavy-Section Steel Technology Program.

In order to use knowledge gained from testing of standard specimens to predict the fracture behavior of reactor pressure vessels, simulated service tests are being devised. In addition, preparations are being made to test plate-like tensile specimens (6 × 8-in. in cross section), and an elastic three-dimensional stress analysis is being performed for the intermediate vessel with an attached nozzle. (L.C.L.)

10048 (ORNL-4463, pp 137-58) DISCUSSIONS. (Oak Ridge National Lab., Tenn.).

From Heavy-Section Steel Technology Program.

A preliminary analysis is made of available fracture toughness data from the Heavy Section Steel Technology program. Included are data on the effects of specimen thickness, strain rate, and temperature on fracture toughness. (L.C.L.)

10049 (ORO-3908-1) A STUDY OF THE STRUCTURE AND MECHANICAL PROPERTIES OF ORDERED ALLOYS. Technical Progress Report, April 1–December 31, 1968. LeFevre, B. G.; Starke, E. A. Jr. (Georgia Inst. of Tech., Atlanta. School of Chemical Engineering). Dec 1969. Contract AT(40-1)-3908. 47p. Dep. CFSTI.

The microstructure of Ni_3Si and that of Ni_4Mo were studied for correlation with the mechanical properties of these ordered materials. Initial studies of Ni_3Si indicated that this phase was difficult to obtain without contamination by Ni_5Si_2 which embrittled the samples. Consequently, studies of Ni-Si alloys were terminated. The ordering of Ni_4Mo during isothermal aging at 700°C was found to proceed homogeneously until late in the process when a heterogeneous reaction was initiated along the grain boundaries. The large increase in strength during ordering of this alloy is attributed to the domain size and the stresses induced due to the tetragonality of the ordered phase. The decrease in ductility during ordering is a result of either the development of dislocations in coplanar arrays or concentrated slip in the heterogeneous component. (auth)

10050 (UCRL-19072) LANTHANUM DIFFUSION IN MOLTEN URANIUM. Le Borgne, Edmond (California Univ., Berkeley. Lawrence Radiation Lab.). Oct 1969. Contract W-7405-eng-48. 41p. Dep. CFSTI.

Thesis.

The diffusion coefficient of lanthanum in molten uranium, at microscopic and macroscopic concentrations was investigated. To get the diffusing element at microscopic concentrations, a uranium rod was irradiated to generate approximately 10^{-9} atom fraction lanthanum-140. The irradiated rod was placed next to an unirradiated rod and the lanthanum allowed to diffuse into the unirradiated uranium rod. The diffusion of lanthanum was determined by measuring the intensity of the 1.6 MeV lanthanum-140 photopeak along the rod. However, the diffusion process at such low concentrations could not be represented by a diffusion coefficient and could not be separated from mixing due to convection and to melting and freezing. The diffusion coefficient of lanthanum in molten uranium at macroscopic concentrations (~0.01 atom fraction lanthanum) was measured by putting a small amount of lanthanum on top of a uranium rod, letting it diffuse, and measuring the penetration of lanthanum along the rod. The diffusion coefficient obtained by this method, $\sim 4 \times 10^{-7}$ cm^2 sec^{-1}, was much lower than expected. The reason for the low diffusivities was probably the presence of bubbles or voids in the liquid uranium. (auth)

10051 (UCRL-71654) NON-DESTRUCTIVE CHARACTERIZATION OF HYDROGEN-EMBRITTLEMENT CRACKING BY ACOUSTIC EMISSION TECHNIQUES. Dunegan, H. L.; Tetelman, A. S. (California Univ., Livermore. Lawrence Radiation Lab.). 10 Nov 1969. 39p. (CONF-691023-1). Dep. CFSTI.

From ASM Materials Engineering Congress and Exposition, Philadelphia, Pa.

Acoustic emission techniques were used to determine the rate of cracking of high-strength steel due to hydrogen embrittlement, making it possible to predict failure in certain structural components undergoing hydrogen attack. The acoustic emission rate from a hydrogen-charged, linear-compliance, fracture-toughness specimen of high-strength 4340 steel was recorded as a function of the stress-intensity factor at the crack tip in the specimen. The structural component (a hydrogen-charged bolt of the same material) was then torqued down in a simple fixture and the acoustic emission was recorded as a function of time. The acoustic emission rate obtained from a near-critical value of the stress-intensity factor of the fracture-toughness specimen was used to predict within ±15 per cent the time for the onset of unstable failure of the bolt. The most significant result of this investigation is that regardless of the initial loading, nucleation time for cracking to begin, or any other factors connected with geometrical differences in specimens, the acoustic emission rate can be used to

determine the time for the stress intensity factor at the onset of rapid fracture. (auth)

10052 THERMAL EXPANSION OF ZIRCONIUM REFRACTORIES. Filatov, S. K.; Frank-Kamenetskii, V. A.; Zhuravina, T. A. (Leningrad State Univ.). Izv. Akad. Nauk SSSR, Neorg. Mater.; 5: 346-51(Feb 1969). (In Russian).

Axial, linear, and volumetric thermal expansion coefficients (KTP) of monoclinic ZrO_2, tetragonal $Zr_{0.8}Ce_{0.2}O_2$, and cubic $Zr_{0.88}Ca_{0.12}O_{1.88}$ crystals were measured. The anisotropic behavior of monoclinic ZrO_2 was established during heating. The polymorphic transformation of ZrO_2 from the monoclinic phase at 1090°C is accompanied by a decrease in volume of the elemental cell by 3.45 ± 0.10 percent. The addition of cerium in the tetragonal ZrO_2 increased dimensions and reduced KTP. (tr-auth)

10053 CATHODE SPUTTERING OF METALS BY SLOW MERCURY IONS. Askerov, Sh. G.; Sena, L. A. (Leningrad Mining Inst.). Sov. Phys.-Solid State (Engl. Transl.); 11: 1288-93(Dec 1969).

Translated from Fiz. Tverd. Tela; 11: 1591-7(Jun 1969).

The sputtering coefficients were measured at the lowest possible ion energies to estimate the threshold sputtering energy. A method using geometrical and magnetic compression of the plasma was developed which allowed one to obtain ion current densities up to 0.5 A/cm^2. The measurements were made with ion energies from 20 to 200 eV. In the low-energy region, the relative sputtering coefficient S is satisfactorily represented by a line $S^{1/2} = K(E - E_0)$, where E_0 is the threshold sputtering energy. Comparison of the threshold energies with various characteristics of the metals does not give a unique relation, but it is possible to see a definite tendency (growth with increasing melting temperature, hardness, etc.). The parameter which best determined the threshold energy is the ratio of the heat of sublimation of the metal to the fraction of the energy transferred during a collision of an ion with a target atom. The threshold energies of all the metals as a function of this parameter, with the exception of chromium, lie satisfactorily on a single monotonically rising curve. (auth)

10054 DIFFUSION OF NICKEL IN THE ALLOY Ni–20 AT. PERCENT Mo IN AN ELECTRIC FIELD. Kalinovich, D. F.; Kovenskii, I. I.; Smolin, M. D.; Statsenko, V. M. (Inst. for Problems in the Study of Materials, Kiev). Sov. Phys.-Solid State (Engl. Transl.); 11: 1397-8(Dec 1969).

Translated from Fiz. Tverd. Tela; 11: 1723-5(Jun 1969).

The electrical transport and diffusion of Ni in Ni–20 at. % Mo were investigated at 950 to 1300°C. ^{63}Ni electroplated on alloy wires were heated by a direct current, which also produced an electric field. The results fit the diffusion equation, D = 0.19 exp (–48,800/RT) cm^2/sec. The effective charges Z* were also measured and found to fall in the range –10 to –8 el. un.; the results follow the equation $Z^* = Z + b/(T + \rho_0/\alpha)$, where Z = 3.1 el. un. and b = –33,200 el. un. deg. (D.L.C.)

10055 A LIMITED COMPARISON OF THE MECHANICAL STRENGTH OF AUSTENITIC STEEL IN 1200 F SODIUM, AIR, AND HELIUM. Kirschler, L. H.; Andrews, R. C. (MSA Research Corp., Evans City, Pa.). J. Basic Eng.; 91: 785-91 (Dec 1969).

The mechanical properties of Type 316 stainless steel were measured at room temperature and at 1200 F during exposure to environments of air, helium, and clean sodium. The test results are given. The small changes seen in the rupture, creep, and tensile tests, due to different environments, are considered insignificant when compared to overall variations between heats of stainless steel. The differences seen in cyclic strain tests reflect changes in material surface condition produced by environment. (auth)

10056 PARAMETRIC INFLUENCE ON THE WALL-THICKNESS CHANGES AND THE BULK STRAIN BEHAVIOR OF HOLLOW-DRAWN TUBING. Flinn, J. E. (Washington State Univ., Pullman). J. Basic Eng.; 91: 792-809(Dec 1969).

The hollow-drawing behavior of tubing with γ_0 values (ratio of initial wall thickness to outer radius) between $0 < \gamma_0 < 1$ was studied. The effect of various parameters on wall-thickness changes during hollow drawing through conical shaped dies was examined. The parameters which influenced the wall thickness changes were die-angle, alloy or metal, and γ_0. The reduction per pass or magnitude of draft had only a slight or negligible effect. An examination of the wall-thickness changes in terms of current theories is made. The bulk true strain behavior of hollow-drawn tubing was also evaluated for several metals. These strains were the elongation, hoop, and thickness, and they were examined between the limits of a rod and an infinitely thin-wall tube. These limits and the constancy of volume principle suggested that the strains could be represented by $\epsilon = C\ln r/r_0$, where C is a coefficient peculiar to each strain. (auth)

10057 NOTCH-BEND STRENGTH OF TITANIUM, ALUMINUM, AND COPPER-BASE ALLOYS IN HEAVY SECTIONS. Chu, Huai Pu (Naval Ship Research and Development Center, Annapolis, Md.). J. Basic Eng.; 91: 83040(Dec 1969).

The notch-bend strength of four titanium, eight aluminum, and eight copper-base alloys was measured. Specimen sizes ranged from 0.4 to 4 in. in section thickness. All materials showed a geometrical size effect on notch strength. Only the high-strength aluminum alloys were found to be prone to brittle fracture. In general, 7 Al–2Nb–1Ta titanium, 5456-H321 and 6061-T6 aluminum, and the copper alloys can be considered as notch-tough materials. The titanium alloys exhibited maximum notch toughness with 6 to 7 percent aluminum content. Determination of plane-strain fracture toughness (K_{Ic}) values for the aluminum alloys is briefly discussed. (auth)

10058 CONDITIONS FOR SERRATED YIELDING IN Va- AND VIa-GROUP METALS. Pink, Erwin (Univ. of Maryland, College Park). Trans. Met. Soc. AIME; 245: 2597-8(Dec 1969).

It is noted that the reason for observed serrations in the stress-strain curve are dissolved impurities on interstitial sites of the lattice. Of importance is the concentration of O, C, and N, which are in random solution. Methods of calculating the concentrations for serrated yielding are evaluated. (J.R.D.)

10059 HARDNESS ANISOTROPY OF VANADIUM AND CHROMIUM. Alexander, D. G.; Carlson, O. N. (Ames Lab., Iowa). Trans. Met. Soc. AIME; 245: 2592-3(Dec 1969).

Microhardness impressions were taken at 10 degree intervals from the common ⟨110⟩ direction by rotating the crystals in the plane of the crystal surface. A Knoop indentor was used with a 400-g load on the V crystals and an 800-g load on the Cr. Microhardness results are presented graphically. (J.R.D.)

10060 EFFECTS OF REHEATING ON THE STRUCTURE AND PROPERTIES OF FAST COOLING Al–Zr ALLOYS. Varich, N. I.; Lyukevich, R. B.; Kolomoitseva, L. F.; Varich, A. N.; Maslov, V. V. (Dnepropetrovsk State Univ., USSR). Fiz. Metal. Metalloved.; 27: 361-4(Feb 1969). (In Russian).

The solubility of zirconium in aluminum at the peritectic transformation temperature of 660.5°C, was 0.28%. At a large cooling rate the content of zirconium in solid solution was noticeably increased and increased with an increase in the temperature of the melt. (tr-auth)

10061 THE MAGNETIC HYSTERESIS OF SUPERCONDUCTING Nb–Sn ALLOYS. II. MAGNETIC HYSTERESIS AND CRYSTALLINE STRUCTURE OF Nb_3Sn. Potapov, N. N. (Central Scientific-Research Inst. of Ferrous Metallurgy, Moscow). Fiz. Metal. Metalloved.; 27: 257-64(Feb 1969). (In Russian).

The parameters of crystalline lattice and grain size of Nb_3Sn (72.2 to 83.5 at. % Nb) were measured to determine superconducting properties. Data were correlated with the magnetic hysteresis study after cooling from room temperature to 4.2°K in a magnetic field. A correlation was found between structural and hysteresis characteristics. (tr-auth)

10062 MECHANICAL PROPERTIES OF CAST IRONS ALLOYED WITH MOLYBDENUM AND TUNGSTEN. Mayer, H. Sulzer Tech. Rev.; 51: 127-32(1969).

Favorable mechanical properties were obtained in cast iron containing flake graphite by adding molybdenum and tungsten to pure charge materials. Compared with ordinary cast iron, high tensile-strength toughness, and elongation values were secured with relatively low hardness. The usual carbon and silicon contents were retained, so as not to impair the good casting properties and other characteristics of cast iron with flake graphite. (auth)

10063 ELASTIC MODULI AND DEBYE TEMPERATURE OF POLYCRYSTALLINE TECHNETIUM BY ULTRASONIC VELOCITY MEASUREMENTS. Love, G. R.; Koch, C. C.; Whaley, H. L.; McNutt, Z. R. (Oak Ridge National Lab., Tenn.). J. Less-Common Metals; 20: 73-5(Jan 1970).

The elastic moduli and Debye temperature of pure polycrystalline technetium were calculated from experimental ultrasonic velocity measurements. Longitudinal and transverse sound velocities were measured by a transit-time technique in which the time interval between successive echoes of an ultrasonic pulse in the specimen was determined. (G.M.C.)

10064 CERTAIN PHYSICAL PROPERTIES OF METALLIC COMPOUNDS OF RHENIUM. Savitskii, E. M.; Khamidov, O. Kh.

Izv. Akad. Nauk SSSR, Metal.; No. 5, 151-5(Sep-Oct 1969). (In Russian).

The critical temperatures of intermediate phases in the systems Sc–Re, Fe–Re, and Re–rare earths were determined and the magnetic properties of metallic compounds of rhenium with various metals were studied. It was established that the physical properties of intermetallic rhenium compounds depend on their crystal structure, electron concentration, chemical nature of the reacting elements, formation of intermediate phases, temperature, and a series of other factors. (tr-auth)

10065 TIME AGING OF ALUMINUM–MANGANESE-ALLOYS WITH CHROMIUM, VANADIUM, OR TITANIUM WITH HIGH VALUES OF SUSCEPTIBILITY. Kopp, Wolf-Ulrich; Wachtel, Ernst (Max-Planck-Institut fuer Metallforschung, Stuttgart). Z. Metallk.; 60: 938-43(Dec 1969). (In German).

High susceptibility-values within certain concentration ranges of ternary aluminum–manganese alloys with chromium, vanadium, titanium indicate ferro- or ferrimagnetism. For aluminum–manganese–chromium they relate with a metastable phase, for aluminum–manganese–vanadium with a CsCl-ordered phase and for aluminum–manganese–titanium with a Laves-phase of the $MgZn_2$-type. Time aging experiments are described. (auth)

10066 EFFECT OF THE COMPOSITION OF CALORIZING BATHS ON THE PROPERTIES OF DIFFUSION BOND IN BIMETALLIC CASTINGS. Vashchenko, K. I.; Firstov, O. M.; Zhyzhchenko, V. V.; Avdokushyn, V. P.; Kostenko, H. D. Visn. Kiiv. Politekh. Inst., Ser. Mashinovuduv.; No. 3, 132-7(1967). (In Russian).

Results are presented of an investigation of the effect of alloying Al with silicon, beryllium, manganese, nickel, and magnesium, and also of complex alloying with a number of elements, on the quality and strength properties of the transitional layer in bimetallic castings of Al–Fe with a diffusion bond. (JPRS)

10067 CHANGE IN DENSITY OF NIOBIUM AND ITS ALLOYS ON ALLOYING. Nedyukha, I. M.; Chernyi, V. G. Izv. Akad. Nauk SSSR, Metal.; No. 5, 208-10(Sep-Oct 1969). (In Russian).

Densities were determined for binary and ternary alloys of Nb with W, Ta, Mo, Ni, Fe, Cr, V, Ti, and Al in a wide concentration range. The alloys Nb–W, Nb–Ta, Nb–Mo, and Nb–V showed unlimited solubility in the solid state. The systems Nb–Ni, Nb–Fe, Nb–Al, Nb–Cr, and Nb–Ti are characterized by the presence of limited solubility in the solid state. (M.C.G.)

10068 CONCENTRATIONAL DEPENDENCE ON MECHANICAL PROPERTIES OF ORDERED ALLOYS NEAR COMPOSITION Mg_3Cd. Kobytev, V. S.; Makogon, M. B. (Physical-Technical Inst., Tomsk, USSR). Ukr. Fiz. Zh.; 14: 1725-7(Oct 1969). (In Russian).

An experimental estimation of stresses of superdislocation blocking (σ_{bl}) in ordered alloys near the composition Mg_3Cd was carried out on the basis of the analysis of the Petch ratio and curves of mechanical hysteresis. Comparison of theoretical curves of concentrational dependences of stresses of superdislocation blocking and experimental values of σ_{bl} results in the conclusion that the main contribution to the yield stress of the alloys under study was made by blocking stresses connected with the state of antiphase boundaries of the superdislocations. (auth)

10069 ESTIMATION OF THE SURFACE ENERGY OF SOME METALS AND REFRACTORY COMPOUNDS. Kislyi, P. S.; Kuzenkova, M. A. (Inst. of Problems of Material Management, Kiev). Porosh. Met., Akad. Nauk Ukr. SSR; No. 10, 39-43(Oct 1969). (In Russian).

An estimation is given of the surface energy of some metals and refractory compounds within the range of configuration approximation. The calculated values of surface energy of metals and refractory compounds are compared with the calculation data of other authors and available experimental values. (auth)

10070 SENSITIVITY OF NIOBIUM–MOLYBDENUM ALLOYS TO HYDROGEN. Talbot-Besnard, Simone (Centre d'Etudes de Chimie Metallurgique, Vitry-sur-Seine, France). Compt. Rend., Ser. C; 269: 962-3(29 Oct 1969). (In French).

Some niobium–molybdenum alloys of various proportions were prepared by vacuum fusion. Placing some of these alloys in a hydrogen atmosphere at ordinary temperatures produced fritting. This phenomenon was only produced in alloys containing 60 to 75% Nb. (tr-auth)

10071 HIGH TEMPERATURE ELECTROCHEMICAL DETERMINATION OF THE THERMODYNAMIC STABILITY OF THE IRON-RICH, IRON–NIOBIUM INTERMETALLIC PHASE. Barbi, Giovanni B. (EURATOM–Joint Research Center, Ispra, Italy). Z. Naturforsch.; 24a: 1580-5(Oct 1969).

A non-stationary technique of emf measurements after polarization of solid galvanic cells, previously applied to the determination of the standard free energy of formation of metal oxides, was extended to intermetallic phases. The chief condition of applicability of this technique to intermetallic compounds is that the rates of recombination of the cathodic reduction products to yield the stable intermetallic phase be high as compared with that of chemical oxidation at the interface with the solid intermediate electrolyte, due to oxygen impurities in the gas phase. In particular, the solid electrolytic cell: Pt $|Fe + FeO|ThO_2/(+LaO_{1.5})|$ $Fe + Fe_{1-y}Nb_2 + NbO_2|Pt$ (y values expressing the ϵ-phase iron-rich boundary compositions according to different authors investigations) was examined. Values of the standard free energy of formation of $Fe_{1-y}Nb_2$ from the elements, ranging between $-3.77 + 0.72 \cdot 10^{-3}$ T and $-5.66 + 1.09 \cdot 10^{-3}$ T kcal/atom were found. (auth)

10072 THERMAL CONDUCTIVITY OF HIGH-PURITY THORIUM. Schettler, H. G.; Martin, J. J.; Schmidt, F. A.; Danielson, G. C. (Ames Lab., Iowa). Phys. Rev.; 187: 801-4(15 Nov 1969).

The thermal conductivity and the electrical resistivity of three high-purity thorium samples with resistivity ratios 31, 140, and 480 have been measured as functions of temperature from 3 to 300°K. The samples were purified by the electrotransport method. Each of the higher-purity samples showed a large thermal conductivity maximum near 10°K and a constant thermal conductivity from 70 to 200°K. At low temperatures, the Lorenz ratios of samples having intermediate purity show, in addition to the linear term arising from electronic thermal conductivity, a quadratic term arising from phonon thermal conductivity limited by phonon–electron scattering. At higher temperatures, the phonon thermal conductivities of these samples vary inversely as the temperature owing to the dominance of umklapp phonon–phonon scattering. The ideal electronic thermal resistivity from 14 to 25°K was proportional to the square of the temperature as expected for electron–phonon scattering. (auth)

10073 SOLUBILITY OF THORIUM IN LIQUID BISMUTH. Schilling, C. E.; Ferris, L. M. (Oak Ridge National Lab., Tenn.). J. Less-Common Metals; 20: 155-9(Feb 1970).

The solubility of thorium in bismuth was determined over the temperature range 450 to 900°C, using a filtration technique. Data obtained using mild steel equipment can be represented by the expression: $\log_{10} S(\text{ppM Th}) = 7.7085 - 3852/T(°K)$. Several data points were obtained using molybdenum apparatus. These values are in good agreement with those determined in mild steel. (auth)

10074 THREE-STAGE HARDENING IN VANADIUM SINGLE CRYSTALS. Mitchell, T. E.; Fields, R. J.; Smialek, R. L. (Case Western Reserve Univ., Cleveland). J. Less-Common Metals; 20: 167-70(Feb 1970).

Some preliminary results on yield stresses and work-hardening characteristics as a function of purity for vanadium single crystals deformed in tension are reported. (auth)

10075 THE SURFACE ENERGIES OF SOLID MOLYBDENUM, NIOBIUM, TANTALUM, AND TUNGSTEN. Hodkin, E. N.; Nicholas, M. G.; Poole, D. M. (Atomic Energy Research Establishment, Harwell, Eng.). J. Less-Common Metals; 20: 93-103 (Feb 1970).

The surface energies of solid molybdenum, niobium, tantalum, and tungsten at 1500°C were determined using the multi-phase equilibration technique. The values obtained were 2050, 2550, 2680, and 2830 erg/cm^2, respectively. The grain boundary energy/surface energy ratios for the four metals varied from 0.28 to 0.38 with an average of 0.32. (auth)

Structure and Phase Studies

Refer also to abstracts 10173, 10617, and 10618.

10076 (ANL–7587) PRELIMINARY ANALYSIS OF DEFECTS IN METALS. Waidelich, D. L. (Argonne National Lab., Ill.). Jul 1969. Contract W-31-109-eng-38. 35p. Dep. CFSTI.

Preliminary analyses leading toward the determination of the response of defects to the pulsed eddy currents used in nondestructive testing are described. The response of a pulsed vertical magnetic field in air above the surface of an infinitely thick metal is the voltage in a pickup coil. A similar analysis for metals having finite thickness is also discussed. A short survey of references involving information about defects is also presented. (auth)

10077 (ANL–7596) COMPATIBILITY OF URANIUM-5 W/O FISSIUM ALLOY WITH TYPES 304L AND 316 STAINLESS STEEL. Zegler, S. Thomas; Rhude, Howard V. Jr.; Lahti, John A. (Ar-

gonne National Lab., Ill.). Sep 1969. Contract W-31-109-eng-38. 15p. Dep. CFSTI.

The compatibility of uranium-5 wt % fissium alloy with two types of stainless steel was investigated in diffusion-couple annealing experiments conducted for up to 10^4 hr at temperatures to 650°C. Types 304L and 316 stainless steel are equally compatible with the uranium-fissium alloy. Penetrations of diffusing elements into the steels in 10^4 hr ranged from a maximum of 7 μ at 550°C to a maximum of 30 μ at 650°C. Type 304L stainless steel reacts slowly with the fuel alloy to form a liquid phase at 705 ± 5°C, and Type 316 stainless steel does so at 715 ± 5°C. Higher concentrations of silicon and aluminum in the fissium alloy have no effect on the compatibility of the alloy with Type 304L stainless steel at 650°C, but the temperature at which a liquid slowly forms is increased to 725 ± 5°C. (auth)

10078 (CEA-R-3881) CONTRIBUTION TO THE STUDY OF THE URANIUM–CARBON–BERYLLIUM TERNARY SYSTEM. Vaugoyeau, Henri (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Nov 1969. 23p. (In French). Dep. CFSTI (U. S. Sales Only).

The isothermal section at 1000°C of the uranium–carbon–beryllium system was determined, and the quasi-linear character of the sections UC–UBe_{13}, UC–Be_2C, and Be_2C–UBe_{13} is illustrated. The very low solubility of beryllium in uranium monocarbide was also evidenced and quenching experiments have thus allowed the study of the limits of the solid solution $UC_{1+x}Be_y$ up to 1900°C. (auth)

10079 (KFK-985, pp 335-58) STRUCTURAL CHANGES IN FUEL ELEMENT CANNING MATERIALS FOR NUCLEAR SUPERHEATERS. Francke, K. P.; Garzarolli, F.; Gerscha, A. (Allgemeine Elektricitaets-Gesellschaft, AEG-Telefunken, Grosswelzheim (West Germany)). (In German).

The structural changes occurring in Inconel 625, Incoloy 800, Hastelloy X-280, and IN 102 in samples of canning pipes and thin sheets were investigated after precipitation at temperatures between 500 and 800°C up to a maximum of 5,000 hrs. The texture was studied by light microscopes and partially by electron microscopes. In inconel 625 after long-term precipitation at temperatures over 550°C grain boundary precipitations, fine precipitations in the grain interior, and spiky precipitations occur. The precipitation ranges of the individual phases were determined with respect to time and temperature. In Incoloy 800 precipitations at the grain boundaries and twinning boundaries occur after long-term exposure at temperatures over 500°C. These precipitations are carbides of the $M_{23}C_6$ type. In Hastelloy X-280 after precipitation at 550° to 730°C broad bands first occur at the grain boundaries. After longer precipitation times these bands disappear and only fine point precipitations are visible at the grain boundaries and in the grain interior. After still longer precipitation times small rods occur in the grain interior and angular bright precipitations are found at the grain boundaries in addition to carbides. The precipitation diagram found is given. In IN 102 various precipitations occur in the grain interior and at the grain boundary after precipitation at temperatures between 650 and 750°C. The grain boundary precipitations have a more or less round form and are a carbide of the M_6C type. In the texture of canning materials of IN 102 in superheated steam grain boundary carbides, gamma-line precipitations, and an orthorhombic overaging phase occur. (J.S.R.)

10080 (ORNL-tr-2252) STUDY OF TERNARY ALLOYS OF URANIUM–MOLYBDENUM–NIOBIUM AND URANIUM–MOLYBDENUM–ZIRCONIUM WITH A LOW-ALLOYING CONTENT. Fizzotti, C.; Masperoni, A. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). Translated for Oak Ridge National Lab., Tenn., from report RT/MET-(68)5. 52p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 23: 24927.

10081 (ORNL-tr-2261) RESEARCHES ON STABILIZATION OF UAl_3 IN NUCLEAR FUELS OF HIGH ALUMINUM CONTENT. Exner, H. E.; Petzow, G. Translated by R. Gregg Mansfield (Oak Ridge National Lab., Tenn.), from Metall; 23: 220-5(1969). 14p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 23: 36133. (J.C.W.)

10082 (YALE-2560-26) X-RAY STUDY OF THE STRUCTURE OF LIQUID METALS AND ALLOYS. Annual Progress Report, January 1, 1969–December 31, 1969. Wagner, C. N. J. (Yale Univ., New Haven, Conn. Dept. of Engineering and Applied Science). Dec 1969. Contract AT(30-1)-2560. 11p. Dep. CFSTI.

The temperature dependence of the structure of liquid Cd, Zn, and Sn was studied using the recently constructed x-ray transmission diffractometer with high temperature camera (for Zn, Cd, and Sn) and the older reflection or theta-theta diffractometer (for Sn only). Both transmission and reflection techniques yielded good agreement for Sn. A decrease of the height of the first peak maximum in I(K) with increasing temperature was observed in Sn, similar to that previously found in liquid In, Tl, and Pb, but only small changes in Cd and Zn. The interatomic distances evaluated from the radial distribution function remained constant or decreased slightly with increasing temperature. The atomic distributions in liquid Cu–Sn alloys were determined from the x-ray scattering measured on the theta-theta diffractometer at temperatures slightly above the liquidus and at 1100°C. The partial interference functions $I_{ij}(K)$ and their Fourier transforms, the pair distribution functions, were evaluated. The concentration dependence of the electronic transport properties could be successfully predicted with the experimental $I_{ij}(K)$ and the theoretical pseudopotentials of the pure elements. (auth)

10083 EQUILIBRIUM DIAGRAM OF THE SYSTEM TANTALUM CARBIDE–RHENIUM. Ordan'yan, S. S.; Kosterova, N. V.; Avgustinik, A. I. (Leningrad Inst. of Tech.). Izv. Akad. Nauk SSSR, Neorg. Mater.; 5: 389-92(Feb 1969). (In Russian).

Phase studies were made of the tantalum carbide–rhenium system from 2100 to 4000°C and the melting temperature was determined in an argon atmosphere. Chemical analyses, metallographic analyses, and x-ray studies were made with the result showing that at 2100°C, rhenium solubility is negligible while the tantalum carbide lattice changes slightly from 4.60 to 4.457 Å in alloys with 5 wt % rhenium. A temperature of 2800°C and annealing for 40 minutes at 2400°C resulted in an increase in solubility of rhenium, but the maximum solubility of rhenium in tantalum carbide does not exceed 1.5 to 2.0 at. % or 3 to 4 wt %. (tr-auth)

10084 CONCENTRATION INHOMOGENEITIES IN SINGLE-PHASE SOLID SOLUTIONS OF THE SILVER–CADMIUM SYSTEM. Shtrakhman, K. M. (Moscow Inst. of Steel and Alloys). Sov. Phys.-Solid State (Engl. Transl.); 11: 1359-61(Dec 1969). Translated from Fiz. Tverd. Tela; 11: 1681-3(Jun 1969).

An investigation of the distribution of relaxation times in the Zener relaxation process, carried out using a method described by Nowick and Berry, yielded the dimensions of concentration inhomogeneity regions in single-phase alloys of the Ag–Cd system containing 35.3, 31.0, and 26.6 at. % Cd. The dependence of the dimensions of the concentration inhomogeneity regions on the concentration of Cd was determined and it was found that these dimensions decreased when the concentration of Cd was increased. (auth)

10085 PRODUCTION AND INVESTIGATION OF SINGLE SILICON CARBIDE CRYSTALS ALLOYED WITH BERYLLIUM. Pichugin, I. G.; Smirnova, N. A. (Electro-Technical Inst., Leningrad). Izv. Akad. Nauk SSSR, Neorg. Mater.; 5: 231-4 (Feb 1969). (In Russian).

A method for alloying silicon carbide crystals with beryllium was developed. The Hall Effect and the electric conductivity at 290 to 1200°C were studied. It was found that the level of beryllium in SiC has an activation energy of 0.35 eV. The concentration of beryllium in the SiC crystals was determined by spectrum analysis. The results compare with the data of the Hall Effect. (tr-auth)

10086 PHASE DIAGRAM OF LANTHANUM–SELENIUM SYSTEM. Yarembash, E. I.; Vigileva, E. S.; Kagramanova, R. R.; Kravchenko, L. Kh. (Inst of General and Inorganic Physics, Moscow). Izv. Akad. Nauk SSSR, Neorg. Mater.; 5: 260-4(Feb 1969). (In Russian).

A phase diagram of the La–Se system was constructed. The chemical compounds discovered were LaSe, La_3Se_4, La_2Se_3, La_4Se_7, $LaSe_2$, and La_3Se_7. For $LaSe_2$, the transition temperature is approximately 1035°C with dimorphism. With the exception of LaSe and La_2Se_3 which are considered as linear phases, the selenides of lanthanum form phases with variable composition, which are crystallized with the defective structures. (tr-auth)

10087 TUNGSTEN CARBIDE PRECIPITATION-HARDENING COBALT–CHROMIUM–TUNGSTEN–CARBON ALLOYS. Knotek, O.; Seifahrt, H. Hart.-Tech. Mitt.; 24: No. 1, 23-6(Apr 1969). (In German).

The Co–Cr–W–C system is discussed and two isothermal phase diagrams, produced from data from investigations of the Co–Cr–W–C system containing C 1 wt % and the Co–Cr–W–Si system containing C 1 and Si 1 wt % at 1050°C, are shown. The results of investigations with various C concentrations, temperature, and Si additions, and studies to show the existence of WC are described. The appearance of WC is explained by the M_6C carbide dissociation reaction. (Metals Abstr.)

10088 DIFFUSION INVESTIGATIONS IN THE SYSTEM Mo–Nb, Mo–Al, AND Nb–Al BY MEANS OF A MICROPROBE. Steeb, S.; Keppeler, R. (Institut fuer Sondermetalle, Stuttgart). Z. Naturforsch.; 24a: 1601–6(Oct 1969). (In German).

Diffusion processes were investigated by means of quantitative electron-probe microanalysis in the systems Mo–Al, Nb–Al and Mo–Nb. With the system Mo–Nb the annealing temperature amounted to 980°C and a smooth run of concentration versus distance was obtained. The diffusion coefficient was dependent on concentration and amounted to $0.7-3.0\cdot10^{-14}$ cm^2 sec^{-1}. In the case of Mo–Al the diffusion zone was composed of the phases Al_5Mo_2, Al_4Mo and $Al_{12}Mo$. The breadth of these phases is discussed in dependence on annealing-temperature and time. Occurrence of volume diffusion could be confirmed. Within the phase Al_5Mo_2 after annealing at 525°C a concentration gradient was obtained, which yielded a diffusion coefficient of $8.47\cdot10^{-4}$ cm^2 sec^{-1}. In the case of Nb–Al the diffusion zone consists of the intermetallic compound $NbAl_3$. (auth)

10089 NEW ASPECTS CONCERNING CRYSTAL-NUCLEATION IN SINTERED SOLID BODIES. Labusca, E. (Inst. of Atomic Physics, Bucharest). Planseeber. Pulvermet.; 17: 172–9(Oct 1969).

Some results are presented on the correlations between crystalline structure and the properties of sintered materials. The principal object of the first stage of the work was to obtain materials with a finer and more homogeneous structure as compared with those obtained so far. A closer investigation of the nucleation process and crystal growth was considered necessary. By a special procedure, a different type of nucleation, not mentioned so far in the literature was induced during the first stage of the sintering process, in materials such as magnetic ferrites and pure iron, and was termed lens type nucleation owing to its shape and symmetry. Another new type of nucleation found in the Ni–Fe–Mo alloys, was designated as a daisy-type of nucleation owing to the radial arrangement of numerous daisy-like nuclei around a circular one. These two new types of nucleation are very interesting as regards the generation and evolution of the crystalline structure and the properties of solid materials. By such means, materials with very fine grains and a very advanced homogeneity of structure were obtained, both qualities being far superior to those obtained by conventional sintering. It is worthy of note that in this way, certain specific properties are also greatly improved. (auth)

10090 ELECTRON MICROSCOPE OBSERVATIONS ON THIN FILMS OF SAMARIUM. Kumar, J.; Srivastava, O. N. (Banaras Hindu Univ., India). J. Less-Common Metals; 20: 70–2(Jan 1970).

Dislocations in vacuum-deposited thin films of samarium were studied. Two types of dislocations produced from electron beam pulse-annealing are described. (G.M.C.)

10091 BORON–GERMANIUM SYSTEM. Bidwell, L. R. (Air Force Materials Lab., Wright-Patterson AFB, Ohio). J. Less-Common Metals; 20: 19–27(Jan 1970).

The salient features of the boron–germanium phase equilibrium diagram were deduced from x-ray diffraction, metallographic, thermal analysis, and electron microprobe studies on both sintered and melted alloys. The system can be characterized as a classical monotectic–eutectic with no intermediate phases. The occurrence of hypomonotectic boron crystals and boron crystals grown from a germanium melt indicated a slight solubility of germanium in solid boron and of boron in liquid germanium at the monotectic temperature. The germanium-rich liquid froze as essentially pure germanium; the solid solubilities of germanium in boron and of boron in germanium were virtually nil at the eutectic temperature. The minute quantity of boron that did dissolve in solid germanium did so substitutionally with a 0.01 to 0.02 vol % contraction of the germanium lattice. These results indicate that germanium may have utility as a boron diffusion barrier for boron fiber-reinforced, metal–matrix composites. (auth)

10092 CURRENT BASIC PROBLEMS IN ELECTROMIGRATION IN METALS. Huntington, H. B. (Rensselaer Polytechnic Inst., Troy, N. Y.). Trans. Met. Soc. AIME; 245: 2571–9(Dec 1969).

Basic problems in understanding electromigration in metals are discussed, along with the attempts that are being made to handle them. One such problem is the effect of the electrostatic forces. It is now acknowledged that the momentum exchange with charge carriers plays generally a dominant role in the driving force but the question remains to what extent the electrostatic force may still be effective. The electromigration of interstitial impurities is also an area which presents questions. For the substitutional impurity, moving by the vacancy mechanism under the influence of an electric field, the correlation considerations are somewhat more complex than have been previously recognized. Another problem of basic importance in the calculation from first principles is the strength of the "electron friction" force, say for a simple one-band metal. A related problem growing out of the preceding is the prediction of the direction of the "electron wind" force for metals with band structure involving both holes and electrons. (auth)

10093 PHASE STRUCTURE AND THE SUPERCONDUCTING PROPERTIES OF ALLOYS OF HAFNIUM–NIOBIUM–TITANIUM–ZIRCONIUM. Raevskii, I. I.; Stepanov, N. V.; Skryabina, M. A.; Dubrovin, A. V.; Alekseevskii, N. E.; Ivanov, O. S. (Inst. of Metallurgy, Moscow). Fiz. Metal. Metalloved.; 27: 235–49(Feb 1969). (In Russian).

X-ray analysis was used to study the phase structure of Nb–Ti–Zr–Hf alloys at 500 to 1500°C. Strongly deformed alloys containing 70 and 50 at. % niobium were also studied. Results were used to construct isothermal cross sections at 1500, 1050, 700, 600, and 500°C. Using specimens of 0.3 mm at 4.2°K the critical density of current was studied in fields 10 to 80 kilogauss for the alloys of both sections in the cold-pressed state. The samples had been annealed at 550°C for 3 hr (the cross section 70 at. % Nb) and 500°C for 2 hr and 380°C for 3 hr (the cross section 50 at. % Nb). (tr-auth)

10094 THE ROENTGENOGRAPHIC AND ELECTRON MICROSCOPE INVESTIGATION OF STRUCTURE OF Ti–50 WT. PERCENT Nb. Vozilkin, V. A.; Sudareva, S. V.; Buinov, N. N. (Inst. of Physics of Metals, Moscow). Fiz. Metal. Metalloved.; 27: 286–92(Feb 1969). (In Russian).

X-ray analysis of diffusion scattering of roentgen rays was used along with electron microscopy to study the structure of Ti–50 wt. % Nb, in various states. The shape of the omega-phase and its change in the process of annealing was studied. Significant angular scatter was found in orientation of the lattices of omega- and alpha-phases in relation to crystallographic position in the matrix. (tr-auth)

10095 PHASE TRANSFORMATIONS IN Mo–Zr ALLOYS. Svechnikov, V. N.; Spektor, A. Ts. (Inst. of Physics of Metals, Kiev). Metalloved. Term. Obrab. Metal.; No. 10, 5–8(1969). (In Russian).

It was found that the eutectoid transformation in the Mo–Zr system occurs at 630°C. With the change of composition and the rate of cooling of the alloys, the decomposition of the beta-phase occurred with the formation of various structures in addition to those observed in the eutectoid decomposition with the formation of fine-grained needle-like structures. Rate of heating had a significant effect on the eutectoid transformation. By means of optimum alloying of zirconium by molybdenum and by the corresponding thermal treatment, it was possible to increase the hardness of the alloys. (tr-auth)

10096 TERNARY ALKALINE AND RARE EARTH SILICIDES AND GERMANIDES WITH $ThCr_2Si_2$ STRUCTURE. Rieger, Wolfhart; Parthe, Erwin (Univ. of Pennsylvania, Philadelphia). Monatsh. Chem.; 100: 444–54(Mar–Apr 1969). (In German).

Fifty-three new compounds of composition $RM_2B_2^{IV}$ were synthesized where R is a rare earth element or Ca and Sr, M is Cr, Fe, Co, Ni or Cu and B^{IV} either Si or Ge. All these compounds crystallize in the tetragonal $ThCr_2Si_2$ (or $CeAl_2Ga_2$) type which is an ordered ternary version of the $BaAl_4$ type, the two nonequivalent sites of the Al atoms being occupied by different kinds of atoms. (auth)

10097 RECOVERY AND RECRYSTALLIZATION OF Mo SINGLE CRYSTALS DEFORMED BY ROLLING. Dubovitskaya, N. V.; Larikov, L. N.; Yakovenko, Yu. D. (Inst. of Physics of Metals, Kiev). Dopov. Akad. Nauk Ukr. RSR, Ser. A; No. 11, 1039–42(Nov 1969). (In Ukrainian).

The recovery and recrystallization of Mo single crystals, deformed in different crystallographic planes were studied by electron transmission microscopy. Under conditions of weak hardening {100} ⟨110⟩ the initial orientation of a single crystal remains unchanged even after a large deformation ($\epsilon \approx 80\%$) and subsequent recovery. Under conditions of large hardening {110} ⟨110⟩ a single crystal stops being a monocrystal at deformation ($\epsilon \approx 80\%$). Its softening results from the poligonization and recrystallization. In case of deformation by 20% under conditions of large deformations, a single crystal is preserved even at the poligonization. (auth)

10098 SOLID-LIQUID PHASE EQUILIBRIA IN THE SODIUM + POTASSIUM SYSTEM. Ott, J. B.; Goates, J. R.; Anderson, D. R.; Hall, H. T. Jr. (Brigham Young Univ., Provo, Utah). Trans. Faraday Soc.; 65: 2870–8(Nov 1969).

Thermal methods were used to determine with high precision,

the solid-liquid phase equilibria diagram for the sodium + potassium system. The melting points of the pure metals and the solid solubility limits were better established by the use of ultra-pure elements and precision thermometry. Considerable effort was expended in a search for intermetallic compounds. No compounds other than Na_2K were formed. (auth) (UK)

10099 INVESTIGATION OF THE PHASE DIAGRAM OF Al–Mg–Zr, IN THE REGION RICH IN ALUMINUM. Drits, M. E.; Kadaner, E. S.; Kuz'mina, V. I. Izv. Akad. Nauk SSSR, Metal.; No. 5, 170-3(Sep-Oct 1969). (In Russian).

Thermal analysis and microstructure investigations were used to study the processes of crystallization in the ternary aluminum system Al–Mg–Zr. Alloys in the limits of concentration studied are in the region of initial crystallization of alpha solid solutions and the compound $ZrAl_3$. The isothermal cross-section of the aluminum corner of the system Al–Mg–Zr at 400°C was constructed. It was established that in equilibrium with the ternary aluminum solid solution there are binary phases present (Mg_2Al_3 and $ZrAl_3$) and a ternary phase, $Al_xMg_yZr_1$. (tr-auth)

10100 PHASE EQUILIBRIA IN THE SYSTEM Mo–Ni–Al. Markiv, V. Ya.; Burnashova, V. V.; Pryakhina, L. I.; Myasnikova, K. P. Izv. Akad. Nauk SSSR, Metal.; No. 5, 180-5(Sep-Oct 1969). (In Russian).

X-ray, microstructural, and thermal analyses were used to construct four isothermal sections at 1200, 1000, 800, and 600°C for the Al–Mo–Ni alloy. In the NiAl–Ni region of the system at 1200 and 1000°C, ternary compounds are not formed. They exist in aluminum-rich alloys. (M.C.G.)

10101 PHASE EQUILIBRIA IN THE SYSTEM Ni–Ni_3Al–Ni_3Nb IN THE TEMPERATURE RANGE 800 TO 1200°C. Guseva, L. N.; Mints, R. S.; Malkov, Yu. S. Izv. Akad. Nauk SSSR, Metal.; No. 5, 186-90(Sep-Oct 1969). (In Russian).

As a result of microstructural and x-ray analyses of the Ni–Ni_3Al–Ni_3Nb system, phase diagrams were constructed at 800, 1080, and 1200°C. Interpolation and extrapolation methods were used to construct isoparametric curves in the single-phase regions of γ and γ'. (M.C.G.)

10102 PHASE DIAGRAM OF THE SYSTEM $TiCr_2$–$NbCr_2$–$ZrCr_2$. Alisova, S. P.; Budberg, P. B. Izv. Akad. Nauk SSSR, Metal.; No. 5, 191-5(Sep-Oct 1969). (In Russian).

Physicochemical methods of analysis were used to study the $TiCr_2$–$NbCr_2$–$ZrCr_2$ section of the Ti–Zr–Nb–Cr alloy. A continuous series of solid solutions was formed between the isomorphous compounds. (M.C.G.)

10103 INVESTIGATION OF THE TERNARY SYSTEM Ti–Zr–Cr. Kornilov, I. I.; Belousov, O. K.; Musaev, R. S. Izv. Akad. Nauk SSSR, Metal.; No. 5, 196-9(Sep-Oct 1969). (In Russian).

The ternary system Ti–Zr–Cr was studied in five polythermal sections with ratios Zr : Cr and Ti : Cr of 2 : 1 and 1 : 2 and Ti : Zr = 1 : 1. Transformation related to the polymorphism of compounds $TiCr_2$ and $ZrCr_2$ are shown. (M.C.G.)

10104 CHARACTER OF THE REACTION OF THORIUM WITH RARE EARTH METALS. Badaeva, T. A.; Kuznetsova, R. I. Izv. Akad. Nauk SSSR, Metal.; No. 5, 156-63(Sep-Oct 1969). (In Russian).

As a result of investigations, phase diagrams were constructed for binary systems of Th with Pr, Nd, Gd, Tb, Dy, Ho, Er, Lu, and Sc. The structure and character of the reaction of the alloys of thorium with Ce, Eu, and Tm were studied. The characteristic phase diagram of thorium–rare earth alloys in a continuous series of solid solutions of high-temperature modifications of elements was studied. In Th-rich alloys with Nd, Gd, Dy, Ho, Er, and Lu maximum $\alpha \rightleftharpoons \beta$ transformations were observed. Thorium does not mix with Yb in the liquid state and it is not possible to introduce more than 1 at.% Eu or 19.5 at.% Tm into liquid thorium. (tr-auth)

10105 ORDERING PROCESSES IN THE ALLOY MgCd AND THEIR EFFECT ON MECHANICAL PROPERTIES. Igonin, G. S.; Makogon, M. B.; Kolobov, V. V. (Physical-Technical Inst., Tomsk, USSR). Ukr. Fiz. Zh.; 14: 1728-31(Oct 1969). (In Russian).

The domain structure of the alloy MgCd was investigated at different states by means of metallography. It was established that at fast cooling from 280°C a fine-domain (lamellar) structure was observed, with stresses arising between the domains. The stresses were recorded by means of x-ray analysis. In tempering the growth of the domains took place with stress relaxation. The domain and dislocation structure of the alloys were considered. A surface picture of deformation was studied. The deformation of this alloy was caused by both sliding and twining. The boundary of domains of different orientation were a great obstacle for shear propagation. High mechanical properties of the alloy appearing at fast ordering were mainly due to a small size of the domains with different orientation. (auth)

10106 HIGH-TEMPERATURE X-RAY INVESTIGATION OF Fe–Al–Cr, Fe–Al–Mo, Fe–Al–W ALLOYS. Selisskii, Ya. P.; Tolochko, M. N. (Moscow Central Research Inst. of Ferrous Metals). Ukr. Fiz. Zh.; 14: 1692-4(Oct 1969). (In Russian).

The influence of Cr, Mo, and W on the atomic ordering in the Fe_3Al alloy was investigated. The temperature and concentration boundaries of the existence of the ordered phases in ternary solid solutions corresponding to the compositions $Fe_3(Al,Me)$ and $(Fe,Me)_3Al$ were determined in the limits of the examined concentrations of the third component (Cr–to 25 at. %; Mo–to 5 at. %; W–to 2.5 at. %). (auth)

10107 CHANGE IN THE TEMPERATURE OF ORDERING OF THE ALLOY Fe_3Al IN ALLOYAGE WITH THE THIRD ELEMENT. Bulycheva, Z. N.; Svezhova, S. I.; Kondrat'ev, V. K. (Central Scientific-Research Inst. of Ferrous Metallurgy, Moscow). Ukr. Fiz. Zh.; 14: 1706-8(Oct 1969). (In Russian).

The critical temperatures of ordering were determined in the Fe–Al–Cr, Fe–Al–W, Fe–Al–Co, Fe–Al–V systems by the dilatometric and resistometric methods and also through the temperature curves of Young's modulus. The increase of critical temperatures of ordering when iron in the Fe_3Al alloy was substituted by alloying elements might be due to the ordered set of all three components. The phase diagrams of Fe_3Al–Me_3Al and Fe_3Al–Fe_3Me are obtained. (auth)

10108 STUDY OF A SHORT-RANGE ORDER IN SOLID SOLUTIONS URANIUM–NIOBIUM AND URANIUM–MOLYBDENUM. Strelova, S. V.; Umanskii, Ya. S. (Moscow Inst. of Steel and Alloys). Ukr. Fiz. Zh.; 14: 1661-3(Oct 1969). (In Russian).

Correlation and atomic arrangement of the components were investigated in solid solution uranium–niobium and uranium–molybdenum by x-ray diffuse scattering. It was established that a short-range ordering appeared in the alloys. The parameters of a short-range order for the first three coordination spheres and those of static distortions due to difference of atomic radii of the components were determined. (auth)

10109 INFLUENCE OF ORDERING ON PROPERTIES OF TERNARY Fe–Al–Cr, Fe–Al–W, Fe–Al–Co, Fe–Al–V ALLOYS. Bulycheva, Z. N.; Svezhova, S. I.; Kondrat'ev, V. K. (Central Scientific-Research Inst. of Ferrous Metallurgy, Moscow). Ukr. Fiz. Zh.; 14: 1702-5(Oct 1969). (In Russian).

The boundaries of the ordered phase of the Fe_3Al type were determined in the Fe–Al–W, Fe–Al–Co, Fe–Al–V systems. The ordering of ternary alloys, as that of binary Fe–Al alloys, was followed by a decrease of the resistivity, Young's modulus and increase of hardness and saturation magnetic induction. The areas of decomposition of ternary solid solution were detected in the Fe–Al–Co, Fe–Al–V systems, where coercivity, hardness, and Young's modulus increased. (auth)

10110 X-RAY STUDY OF THE MERCURY–INDIUM ALLOY SYSTEM. Heller, M. W.; Musgrave, L. E. (Colorado State Univ., Ft. Collins). J. Less-Common Metals; 20: 77-82(Feb 1970).

X-ray diffraction was used to study twenty different alloys in the 0 to 50 at. % indium composition region of the mercury-indium binary system. The continuation of the mercury structure provides evidence for the existence of a mercury solid solution for up to 15 at. % indium. Complex patterns in the 15 to 25 at. % region were observed and classified as a single phase due to a triclinic structure not too different from the simpler rhombohedral mercury structure. A two-phase region is observed from 25 to 45 at. % indium. The high structure was observed at about 50 at. %. The structure was rhombohedral with a = 3.001 A and α = 73°8′. (auth)

Radiation Effects

Refer also to abstracts 10188, 10602, 11159, and 11325.

10111 (BMI–1872, Sect.B) CLADDING, STRUCTURAL, AND COMPONENT MATERIAL STUDIES (AEC-RDT). (Battelle Memorial Inst., Columbus, Ohio). 26p.

Results of investigations are presented on radiation effects on cladding materials as a function of energy of radiation. Other work is reported on effects of microstructure on radioresistance of cladding materials, and on the development of new methods of testing irradiated alloys and metals. (J.R.D.)

10112 (GEMP–721) THE USE OF SPECTRUM AVERAGED CROSS SECTIONS IN THE CALCULATION OF HELIUM GEN-

ERATED IN STAINLESS STEEL DURING REACTOR IRRADIATION. Scherrer, J. F.; Moteff, J. (General Electric Co., Cincinnati, Ohio. Missile and Space Div.). Nov 1969. Contract AT(40-1)-2847. 23p. Dep. CFSTI.

The expected helium generation in Types 304 and 316 stainless steels from fast neutron irradiation (flux of 10^{16} n/cm^2 sec) at different positions in several reactors was calculated using spectrum averaged cross sections. Correction factors to the fission spectrum averaged cross sections were proposed but much more work is required especially in the experimental measurement of the more important (n,α) elemental cross sections. (G.M.C.)

10113 (GEMP-726) NEW CORRELATIONS INVOLVING THE LOW-CYCLE FATIGUE AND SHORT-TERM TENSILE BEHAVIOR OF IRRADIATED AND UNIRRADIATED 304 AND 316 STAINLESS STEEL. Conway, J. B.; Berling, J. T.; Stentz, R. H. (General Electric Co., Cincinnati, Ohio. Nuclear Systems Programs). Dec 1969. Contract AT(40-1)-2847. 71p. (CONF-691102-10). Dep. CFSTI.

From 17th Conference on Remote Systems Technology, San Francisco, Calif.

Short-term tensile data have been generated using a new experimental technique which allows the true total axial strain rate to be maintained constant all the way to fracture. Tensile data at 650°C for irradiated and unirradiated specimens of AISI 304 and 316 stainless steel are presented and compared. The relationship between low-cycle fatigue and short-term tensile behavior is reviewed in terms of the analytical expressions which have been employed in correlations of this type. Two of the more recent correlation equations are reviewed and their effectiveness in describing data for irradiated 304 and 316 stainless steel specimens is illustrated. It is shown that a short-term tensile test of an irradiated stainless steel specimen can be used with these prediction equations to obtain fairly reliable estimates of low-cycle fatigue behavior. Hold times at peak strain have a noticeable effect on fatigue behavior as evidenced in tests at 650°C. These effects are most pronounced when hold periods are employed in only the tension portion of the cycle. An interesting correlation of hold-time data is presented based on a logarithmic plot of time to fracture versus the length of the hold period. Another important correlation involves a relationship which identifies a method for estimating hold-time effects from a knowledge of the effect of strain rate on low-cycle fatigue behavior. (auth)

10114 (GEMP-1012(Pt.1), pp 71-262) RADIATION EFFECTS ON FAST REACTOR CLADDING AND STRUCTURAL MATERIALS. Moteff, J.; Kingsbury, F. D.; Smith, J. P. (General Electric Co., Cincinnati, Ohio. Nuclear Systems Programs).

Irradiation in EBR-II to 0.2 to 2 × 10^{20} n/cm^2 ($E_n \geq 1$ MeV) of Incoloy 800 and Hastelloy X reduces the fracture ductility by a factor of three at 540, 650, and 705°C. Irradiation increases minimum creep, compared with unirradiated controls, for low test temperatures (high stresses) but reduces minimum creep rate at high test temperatures (low stresses). TEM studies of fractured specimens have shown no observable differences in structure. The low-cycle fatigue life of Types 304 and 316 stainless steel at 650°C is reduced by a factor of 2 to 3 by irradiation to 3 to 4 × 10^{18} n/cm^2 ($E_n \geq 1$ MeV) in the ORR at 70°C. Post-test TEM studies on irradiated and unirradiated 316 SS specimens showed definite substructure formation with the subgrain size being the same for irradiated and unirradiated specimens; the subgrain boundaries, however, are much less well defined in the irradiated specimens than in the controls. The creep properties of annealed and of 20 percent cold-worked 304 SS and 316 SS are significantly different. The major effect of cold working on the 705°C creep properties is to reduce minimum creep rate and fracture elongation. At 760°C, the rupture life and rupture ductility of Inconel 625 are reduced by a factor of about 20. Although the minimum creep rate is slightly increased, this is a relatively small effect compared to the effect on ductility and its resulting loss in rupture life. Transmission electron microscopy studies of molybdenum irradiated at 70, 700, and 1000°C to a neutron fluence of approximately 1.3 × 10^{20} n/cm^2 ($E_n \geq 1$ MeV) revealed the presence of polyhedralshaped cavities in the 700°C (0.34 T_m) irradiated specimens were smaller but much greater in concentration than present in the 1000°C (0.44 T_m) irradiated specimens. Calculations showed that the cavities are vacancy-filled voids rather than gas-filled bubbles from (n,α) reactions. Irradiation at 700°C also produced a microstructure with a high density of dislocation loops identified as interstitial in nature. Loops were absent from most grains in specimens irradiated at 1000°C. The effect of irradiation temperature on the creep-rupture properties of polycrystalline molybdenum (two carbon levels, 38 and 220 ppM) at 1000°C was determined. In general, irradiation at 70°C resulted in the least effect on the time to rupture; irradiation at 700 and 1000°C showed increases by factors of approximately 1.4 and 2.5, respectively. Delayed creep was observed in the 700 and 1000°C irradiated specimens. It is believed that the increase in creep strength in the elevated-temperature irradiated specimens may be attributed to the presence of the cavities which act as pinning points. Transmission electron microscopy studies on the microstructure of neutron-irradiated single-crystal vanadium revealed the presence of small defect clusters which, upon annealing, grew into resolvable dislocation loops, analyzed as interstitial in nature. The radiation-induced clusters and loop were stabilized during annealing by interaction with impurity precipitates. Cylindrical shells of enhanced radiation damage surrounding elongated fibrous precipitates were found in irradiated vanadium. The precipitates were identified as tetragonal V_3B_2, and are oriented along ⟨100⟩ directions in the cubic vanadium lattice. The cylindrical damage shells are duplex in nature, consisting of a highly damaged inner region of about 1.3 microns radius and a less highly damaged outer region of about 2.6 microns radius. These two damage shells consist of small defect clusters produced by recoiling lithium ions and alpha particles, respectively, generated by $^{10}B(n,\alpha)^7Li$ transmutation reaction. Preliminary TEM of irradiated vanadium alloys, V-20Ti and VANSTAR-9, indicates that the density of clusters are more numerous than in pure vanadium single-crystal material irradiated under similar conditions. The effect of isochronal anneals on the 400°C tensile properties of tungsten were determined in the 400 to 1300°C temperature range. A minimum in the strength was exhibited at approximately 0.32 T_m (Stage IV recovery region). This behavior is believed due to a local supersaturation of vacancies and dislocation climb promoted by the vacancy mobility in this temperature region. Elevated-temperature tensile tests of recrystallized Ta and Ta-10W irradiated to 1.2 × 10^{20} n/cm^2 ($E_n \geq 1$ MeV) revealed that complete recovery of strength and ductility does not occur until 1050°C. The ductility of Ta-10W was drastically reduced at test temperatures below approximately 600°C. Limited data indicate that Ta exhibits greater radiation-induced hardening than the Ta-10W. Rows 2 and 7 of the EBR-II were accurately flux mapped using experimentally determined specific activities and Monte Carlo calculated spectrum-corrected cross sections. Failure to spectrum correct the cross sections has been shown to result in underpredicting fast fluxes ($E_n \geq 1$ MeV) by a factor of up to 5 in the extremities of row 7. Monte Carlo calculated differential neutron fluxes have also been used to determine the total atom displacement densities and displacement spike densities due to PKA's of energy greater than 3 keV in α-iron for axial positions in the EBR-II rows 2 and 7. Fluence above a given energy, such as 0.1 MeV, is not necessarily a completely sufficient criterion for the evaluation of radiation effects to metals. It is shown that no criterion is completely sufficient. Helium generation calculations were performed on stainless steels and compared with other theoretical and experimental values. The lack of accurate (n,α) cross sections does not permit calculating true helium production values. It is shown how some of the (n,α) fission-spectrum-averaged cross sections can be corrected to what is believed to be their true values. (auth)

10115 (IN-1343) STATUS REPORT ON THE ADVANCED TEST REACTOR MATERIALS SURVEILLANCE PROGRAM. Korth, G. E.; Beeston, J. M.; Zelezny, W. F. (Idaho Nuclear Corp., Idaho Falls). Nov 1969. Contract AT(10-1)-1230. 66p. Dep. CFSTI.

Activities in a program of monitoring irradiation-induced property changes of beryllium and hafnium, to a more limited extent, 6061-T6 aluminum and Types 304, 348, and 17-4 PH stainless steel are summarized. Data provided by this program will be used in predicting the behavior of ATR components, especially the beryllium reflector and the hafnium control rods. The frequency of replacement is dictated by irradiation damage (growth, embrittlement), material optimization in design, and reactivity changes. Preirradiation data of the hafnium, aluminum, and stainless steels are tabulated. These data are to be used as a basis for predicting service life of the ATR components. The schedule for the transfer of the capsules containing beryllium from the ETR to the ATR is presented. Fifteen new capsules will also be inserted in the ATR when it begins Cycle 1. (auth)

10116 (KFK-985, pp 17-34) HIGH-TEMPERATURE EMBRITTLEMENT BY NEUTRON IRRADIATION. Hauck, Hansjuergen (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Material- und Festkoerperforschung). (In German).

It was established by a bibliographic review that the present representations on the mechanisms of high-temperature embrittlement in situ can explain the experimentally found relation between neutron dose and embrittlement. The possibilities given from these representations for the improvement of the irradiation behavior can be experimentally confirmed and could lead to very good results. (tr-auth)

10117 (KFK-985, pp 35-45) SIMULATION OF HIGH-TEMPERATURE EMBRITTLEMENT BY DIRECT INJECTION OF α PARTICLES. Ehrlich, K. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Material- und Festkoerperforschung). (In German).

Although the electron microscopic investigations on the two vanadium systems, V_3A steel and vanadium-based alloys, are still not concluded, and the fracture surface studies can not be interpreted because of the very small grains as clearly in favor of one or another mechanism, a high-temperature embrittlement of the two body centered cubic alloys can be concluded from the mechanical data. Such a result was previously unknown. It indicates that possibly in other body-centered cubic alloys a high temperature embrittlement is to be considered. (tr-auth)

10118 (KFK-985, pp 47-69) PORE FORMATION UNDER IRRADIATION. Boehm, H. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Material- und Festkoerperforschung). (In German).

The previously known results on pore formation in metals as a result of irradiation and a brief summary of the respresentations on the origins of pore formation are presented. The effect of various parameters on pore formation and the property changes caused by the pores are given. The parameters discussed are the effect of gases, the irradiation temperature, the neutron flux, and the neutron dose. It is expected that results of the study will serve as the basis for further experimental and theoretical clarifications. (tr-auth)

10119 (KFK-985, pp 183-206) AUSTENITIC STEELS AS CANNING MATERIALS FOR FAST BREEDER REACTORS. Boehm, Horst (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Material- und Festkoerperforschung). (In German).

A brief bibliographic review is given of the effect of various steel parameters on its use as canning material in fast reactors. The factors affecting the selection of a canning material are connected with the neutron physics aspects and the life time determining magnitudes. The effect of neutron irradiation on the creep rate, the ductility and life of the canning material, and pore formation are discussed. The factors which affect the very complex behavior of austenitic steels under irradiation are indicated. (J.S.R.)

10120 (KFK-985, pp 263-72) IRRADIATION BEHAVIOR OF AUSTENITIC TITANIUM-, MOLYBDENUM-, AND BORON-ALLOYED STEELS. Ljungberg, L. (Aktiebolaget Atomenergi, Studsvik (Sweden)). (In German).

An irradiation study was carried out on three austenitic steels with precipitations of titanium and chromium carbides. The steels studied were 15 Cr/15 Ni/Mo/Ti/B and two variants 19 Cr/25 Ni and 19 Cr/34 Ni. The steels were studied after two different heat treatments. The irradiation was done in a thermal reactor at 700°C up to the dose 4×10^{20} n/cm² (thermal). The helium fraction produced was 20 to 50% of the expected helium content in the same material after use as canning material in a fast reactor operating at 100,000 MWd/teU. The breaking elongation in tensile and stability tests at 600 to 800°C was reduced by the irradiation. The elongation reduction is greatest in materials with 15 or 25% Ni in the upper part of the temperature range studied. (tr-auth)

10121 (KFK-985, pp 289-301) IRRADIATION BEHAVIOR OF NICKEL ALLOYS. Hauck, Hansjuergen (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Material- und Festkoerperforschung). (In German).

A brief bibliographic review is given of the behavior of nickel alloys under irradiation. The irradiation studies on Inconel-625 showed that the good long-range stability and ductility of this alloy was so sharply reduced by irradiation that its use as canning material was questionable. The short-time stability properties of Hastelloy X were not reduced by irradiation. The irradiation behavior of Incoloy-800 depends strongly on the content of the alloying elements Al, Ti, and C. The irradiation behavior of Ni alloys is improved by the addition of Ti, Zr, or Hf. These increase both the stability and the ductility. The favorable results of a preliminary thermomechanical treatment was illustrated by results obtained on Inconel-625 and Hastelloy X. (J.S.R.)

10122 (KFK-985, pp 313-34) ASPECTS FOR CHANGES IN THE SECONDARY CREEP RATES OF INCONEL 625, INCOLOY 800, AND 16/16 Cr-Ni STEEL BY HIGH-TEMPERATURE NEUTRON IRRADIATION. Francke, K. P.; Garzarolli, F. (Allgemeine Elektricitaets-Gesellschaft, AEG-Telefunken, Grosswelzheim (West Germany)). (In German).

Studies were made on Inconel 625, Incoloy 800, and 16/16 Cr-Ni steel to determine the long-range behavior under thermal stress in the range from 500 to 800°C, the fatigue strength behavior, the stability behavior, texture changes, and microstructural processes. The irradiation was done at 650°C. The change of the creep rate was especially evaluated. The results showed that in all the alloys the long-range stability and fracture and the secondary creep rate was higher in the irradiated samples than in the non-irradiated samples. The smallest decrease of the long-range stability was found in the 16/16 Cr-Ni steel. The decrease of the long-range stability was somewhat higher in the Incoloy 800 and amounted to 20 to 22%. The creep rate decreased only about 9 to 12%, while in the 16/16 alloy it decreased 12 to 16%. The highest decrease of the long-range stability was measured in Inconel 625 with 46%. A creep rate of 25% was established for this alloy. The long-range breaking elongation of this alloy was also lower after irradiation than in the other alloys. The significance of these results were discussed. (J.S.R.)

10123 (ORNL-4463, pp 89-121) INVESTIGATIONS OF IRRADIATED MATERIALS. (Oak Ridge National Lab., Tenn.).

From Heavy-Section Steel Technology Program.

The initial program phase of the irradiation effects task was identified and this phase is in process. Fracture toughness K_{Ic} results from irradiated specimens were obtained for A533 plate (8 in. thick) and weld (11¾ in. thick) material and for a forging-grade material. Temperature shifts due to irradiation of up to 250°F were found for K_{Ic} results at irradiation of around 4×10^{19} neutrons/cm² at approximately 550°F. Irradiation of HSST 12-in.-thick plate is nearing completion. Preparations are under way for additional irradiation of program plate and weldments. A metallographic study was made of irradiated steels for correlation with embrittlement due to irradiation. Irradiation of ⅝-in. dynamic-tear specimens is in process as is the irradiation of Charpy and tensile specimens. (L.C.L.)

10124 (ORNL-TM-2647) AN EVALUATION OF THE MOLTEN-SALT REACTOR EXPERIMENT HASTELLOY N SURVEILLANCE SPECIMENS: THIRD GROUP. McCoy, H. E. Jr. (Oak Ridge National Lab., Tenn.). Jan 1970. Contract W-7405-eng-26. 88p. Dep. CFSTI.

Studies were made on the third group of Hastelloy N surveillance samples removed from the Molten-Salt Reactor Experiment. Standard Hastelloy N was removed from the core after exposure to a thermal fluence of 9.4×10^{20} neutrons/cm² over a time period of 15,289 hr at 650°C and from outside the reactor vessel after exposure to a thermal fluence of 2.6×10^{19} neutrons/cm² over a time period of 20,789 hr at 650°C. The former samples were exposed to the fuel salt and the later samples were exposed to nitrogen plus 2 to 5% O_2. The material seemed quite compatible with both environments. Postirradiation tests showed that the fracture strain was reduced at 25°C and above 500°C. The reduction in ductility at 25°C is likely due to carbide precipitation and the reduction above 500°C is due to the presence of helium from the $^{10}B(N,\alpha)^{7}Li$ transmutation. The accumulated results in this series of experiments allow us to follow the changes in fracture strain over the thermal fluence range 1.3×10^{19} to 9.4×10^{20} neutrons/cm². Two heats of modified Hastelloy N were removed from the core after irradiation to a thermal fluence of 5.3×10^{20} neutrons/cm² over a time period of 9789 hr at 650°C. The postirradiation properties of these alloys were better than those of standard Hastelloy N. (auth)

10125 (WCAP-7328(Rev.)) EVALUATION BY LINEAR ELASTIC FRACTURE MECHANICS OF RADIATION DAMAGE TO PRESSURE VESSEL STEELS. Heavy Section Steel Technology Program Technical Report No. 5, November 1969. Mager, T. R.; Thomas, F. O. (Westinghouse Electric Corp., Pittsburgh, Pa. PWR Systems Div.). Oct 1969. Contracts AT(30-1)-3677; W-7405-eng-26; Subcontract 3209. 122p. Dep. CFSTI.

For Oak Ridge National Lab., Tenn.

The development and evaluation of a fracture mechanics approach to the problem of brittle fracture of reactor vessel materials was investigated. Experiments were performed to determine the fracture toughness of a variety of pressure vessel materials in both the unirradiated and irradiated conditions. Included in the investigation were plate, forging, weld- and heat-affected zone samples of materials commonly used in the fabrication of nuclear pressure vessels. The integrated neutron flux of those specimens which were irradiated was comparable to that conservatively estimated for large, pressurized water reactors. The results demonstrated that effect of irradiation on the mechanical properties of pressure vessel materials. The effects on the more conventional tensile and transition temperature properties were correlated with the fracture toughness, and the varying sensitivity to irradiation of the different materials was evaluated. Included in the results are the variations of mechanical

properties through the thickness of a 12-inch-thick plate of ASTM A 533, grade B, class 1 steel. The effects of stress during irradiation on the fracture toughness were also considered. (auth)

10126 EFFECT OF GRAIN BOUNDARY-DISTRIBUTED BORON ON HIGH TEMPERATURE PROPERTIES OF IRRADIATED STEELS. Votinov, S. N.; Prokhorov, V. I.; Shamardin, V. K.; Ostrovskii, Z. E.; Grinchuk, P. P. At. Energ. (USSR); 27: 506-10(Dec 1969). (In Russian).

Mechanical properties and microstructure of austenitic stainless steels, OX16H15M3B, OX16H15M3BP (different in boron content), and 00X16H15, irradiated in a reactor at 650°C by 1.5×10^{20} n/cm² (thermal) and 2×10^{20} n/cm² (>1 MeV) were studied. The experimental results indicated that the grain boundary boron was not a main cause of high temperature radiation embrittlement. The maximum embrittlement was observed in 00X16H15 steel which had more uncontrolled impurities but unalloyed by Mo, Nb, and B which are able to make the grain boundaries resistant to wedge cracking and cavitation. (auth)

10127 STEELS FOR COMMERCIAL NUCLEAR POWER REACTOR PRESSURE VESSELS. Sterne, R. H. Jr. (Lukens Steel Co., Coatesville, Pa.); Steele, L. E. Nucl. Eng. Design; 10: 259-307(Jul 1969).

The properties of carbon and low alloy steels currently used in the USA for commercial nuclear power reactor pressure vessel construction were examined in reference to higher strength–higher alloy steels having potential for advanced reactor service. Emphasis was placed upon the characteristics of selected vessel steels which are critical to the intended service function and the influence of fabrication and the service environment in changing important mechanical properties. Recent developments for assessing these properties after simulated nuclear service are reviewed along with techniques for minimizing the effects of radiation. The review placed much emphasis upon improved properties for steels which slowed strong potential for future nuclear structural application. Engineering considerations are cited only to highlight the descriptive review of pressure vessel steels, current and future, and their capacity for meeting the critical functions required of a reactor primary containment vessel. (auth)

10128 INVESTIGATION OF RADIATION EFFECTS OF MONOCRYSTALS WITH IONIC PROJECTOR. Suvorov, A. L.; Kukavadze, G. M. Fiz. Metal. Metalloved.; 27: 347-8(Feb 1969). (In Russian).

The effects of deuteron bombardment on annealed tungsten wire of 0.5 mm dia at 12 MeV were studied. The results showed no significant destruction. Irradiation was performed in an ion-conducting cyclotron in room temperature and then studied in a multipurpose ionic projector. Graphical ion images of the examined area are given. (R.V.J.)

10129 EFFECTS OF γ-QUANTA IRRADIATION ON THE CREEP PROCESS IN ZINC MONOCRYSTALS. Troitskii, O. A.; Kalinin, V. A. (Inst. of Physics of Solids, Moscow). Fiz. Metal. Metalloved.; 27: 327-30(Feb. 1969). (In Russian).

The anisotropy of the influence of radiation from ^{60}Co on creep of zinc monocrystals was studied, first with an unstable rate of deformation and also with a stable rate of deformation. It was found that irradiation increased the rate of creep on the first condition and has no influence on the second. The orientation of crystals being irradiated showed that elements of slip along the stream of quanta cause the additional increase in rate of unstable creep. (tr-auth)

10130 ULTRASONIC NONDESTRUCTIVE MEASUREMENT OF IRRADIATION DAMAGE IN STEEL. Hunter, D. O. (Battelle Memorial Inst., Richland, Wash.). Contract AT(45-1)-1830. J. Basic Eng.; 91: 593-7(Dec 1969).

Measurements of changes in ultrasonic velocities and critical angle method signal amplitude were made on reactor irradiated A302-B, A542-B, and 304 steels. Results showed a strong sensitivity to neutron fluence and irradiation temperature. Changes at lower irradiation temperatures appear correlative to some irradiation degraded changes in mechanical properties. (auth)

10131 INFLUENCE OF GAMMA IRRADIATION ON THE METAL–GAS REACTIONS ON IRON SURFACE. Teodorescu, I.; Zberea, I. (Inst. of Atomic Physics, Bucharest). Stud. Cercet. Fiz.; 21: 985-90(1969). (In Rumanian).

Gamma irradiation of pure iron led to evident surface microrelief changes. The electron microscopy and electron diffraction studies showed that these changes depended on the nature of the sample surface existing before irradiation, air pressure in the irradiation tube, covering of the sample with an aluminium lamella, and irradiation dose. The results obtained in this work present the separation of the gamma irradiation effects from the reactor neutron ones. (auth)

10132 ON ORDERING AND DISORDERING IN ALLOYS DUE TO THE IRRADIATION. Artsishevskii, M. A. (Central Scientific-Research Inst. of Ferrous Metallurgy, Moscow). Ukr. Fiz. Zh.; 14: 1741-5(Oct 1969). (In Russian).

On the basis of the experimental data it is supposed that two opposite processes (ordering and disordering) are going on simultaneously during irradiation of ordered alloys. The resultant effect depended on the temperature, dose, and intensity of irradiation, as well as on the type and energy of the incident particle and on the composition and initial state of the alloy. Analysis of the results made it possible to explain qualitatively the observed effects of ordering and disordering due to irradiation. (auth)

Ceramics and Cermets

Refer also to abstracts 9986, 9987, and 9991.

10133 DICTIONARY OF FUEL TECHNOLOGY. Gilpin, A. London; Butterworths (1969). 275p. 42s.

Entries are included covering nuclear fuel technology. (UK)

10134 CERAMIC NUCLEAR FUELS. Proceedings of the International Symposium, May 3–8, 1969, Washington, D. C. Kruger, Owen L.; Kaznoff, Alexis I. (eds.). Columbus, Ohio; American Ceramic Society, Inc. (1969). 253p. $20.00. (CONF-690512).

Twenty-two papers were presented at the conference. A separate abstract was prepared for each paper. (J.R.D.)

For abstracts of individual papers see: 10135, 10151–10153, 10167–10169, 10185–10187, and 10201–10212.

Corrosion and Erosion

Refer also to abstract 10187.

10135 INTERACTION BETWEEN URANIUM CARBIDE AND REFRACTORY METALS. Coen, V.; Hausner, H.; Kolbe, H.; Quataert, D. (EURATOM–CCR, Ispra, Italy). pp 147-55 of Ceramic Nuclear Fuels. /Kruger, Owen L. (ed.). Columbus, Ohio; American Ceramic Society, Inc. (1969).

From 71st Annual Meeting of the American Ceramic Society, Washington, D. C. See CONF-690512.

$UC_{1.92}$ in contact with Ta, Nb and Mo has shown a slight reaction during heat treatments up to several thousand hours at 1200°C. The parabolic rate constants for the carbide layer growth have been determined and increase from Ta toward Mo. At higher temperatures the parabolic growth proceeds as long as UC_2 is present, followed by a liquid phase formation in the case of Ta and Nb, whereas the reaction does not continue in the case of Mo. The carbide layers do not protect the metal against the penetration of the liquid uranium, resulting in an excessive reaction between the carbide and Ta or Nb. (auth)

Preparation and Fabrication

Refer also to abstracts 9437, 9502, 9569, and 11200.

10136 (ALO-2510-7) SILICON GERMANIUM THERMOELECTRIC MATERIALS AND MODULE DEVELOPMENT PROGRAM. Quarterly Report No. 7, July 1–September 30, 1969. (RCA, Harrison, N. J.). Contract AT(29-2)-2510. 51p. Dep. CFSTI.

Progress during the period includes installation of a new hot-press chamber and establishment of thermoelectric material pressing parameters. Evaluation specimens of SiMo and SiGe were hot pressed to near theoretical density without difficulty. Metallographic analysis of W–Al–ceramic and SiMo–SiGe junctions showed partial separation of the former and surface porosity in the latter. Air tests of 80 at.% SiGe thermocouple at high temperatures revealed better stability than is demonstrated for the 63.5 at.% Si thermocouple. The design and parts detailing for the C-4 converter were almost completed during the quarter. Shock and vibration test results of C-3 foil-insulated converter indicate that the converter performance did not change and the insulation did not deteriorate. The reference design converter completed over 10,000 hr of operation with a degradation of approximately 3%. A four-thermocouple module completed over 4500 hr of operation at approximately 1150°C. (J.R.D.)

10137 (ALO-2510-T-1) SILICON GERMANIUM THERMOELECTRIC MATERIALS AND MODULE DEVELOPMENT PROGRAM. Topical Report, January 1, 1968–November 1, 1969.

(RCA, Harrison, N. J.). Contract AT(29-2)-2510. 83p. Dep. CFSTI.

A comprehensive study of air-vacuum materials was performed under this contract. The material properties and the test data derived or verified are reported. Properties of air-vac materials in element forms also are discussed. (auth)

10138 (BMI-1872, Sect.A) URANIUM-PLUTONIUM NITRIDE FUELS FOR LMFBR APPLICATIONS (AEC-RDT). (Battelle Memorial Inst., Columbus, Ohio). 31p.

Results of investigations are reported on thermodynamics of PuN and PuN-UN, reactions between UO_2 and U_3N_2 at 1500°C, PuN-UN compatibility with cladding, determination of N in Na, diffusion in nitride fuels, thermal radiation effects on nitride fuels, thermal radiation effects on PuN-UN fuels, preparation of EBR-II fuel pins and fabrication of irradiation capsules. (J.R.D.)

10139 (BMwF-FBK-69-41) FABRICATION OF POROUS COMPACTS OF URANIUM MONOPHOSPHIDE. Moench, S. (Max-Planck-Institut fuer Metallforschung, Stuttgart (West Germany). Institut fuer Sondermetalle). Nov 1969. 48p. (In German). Dep. CFSTI (U. S. Sales Only). ZAED DM 10.10.

A method for the production of uranium monophosphide (UP) from its elements is described. The reaction product contained less than 0.3 weight % oxygen and was characterized with respect to composition, surface properties, particle size, and powder density as well as milling and pressing behavior. The sintering processes in high vacuum were investigated by measurement of density, weight losses, specific surfaces and by the determination of topological parameters. From the results three temperature dependent material transport mechanisms could be deduced. The process of fission gas removed by diffusion in porous reactor materials is discussed. The condition for the stationary state between formation and removal of fission gases during radiation is deduced. (auth)

10140 (GEMP-717) Ni-BASE ALLOY FUEL DISPERSIONS. Robertshaw, F. C. (General Electric Co., Cincinnati, Ohio. Nuclear Systems Programs). 19 Dec 1969. Contract AT(40-1)-2847. 34p. Dep. CFSTI.

Properties of plate-type fuel elements prepared by powder metallurgy using UO_2 in a matrix of 80 Ni-20 Cr were examined. Cladding for such elements composed of 80 Ni-20 Cr alloy is discussed along with braze alloys composed of 20 Cr-10 Si-Ni for sealing. Data are included on radiation effects and tensile tests. (J.R.D.)

10141 (GEMP-718) FERRITIC STAINLESS STEEL FUEL DISPERSIONS. Robertshaw, F. C. (General Electric Co., Cincinnati, Ohio. Nuclear Systems Programs). 5 Dec 1969. Contract AT(40-1)-2847. 20p. Dep. CFSTI.

Properties of fuel elements composed of UO_2 dispersed in ferritic stainless steel are tabulated and discussed. Cladding variations for these elements including stainless steel, and Fe-base-30 Cr-1 Y alloys are examined. Data and micrographs are included. (J.R.D.)

10142 (GEMP-719) AUSTENITIC STAINLESS STEEL FUEL DISPERSIONS. Robertshaw, F. C. (General Electric Co., Cincinnati, Ohio. Missile and Space Div.). 19 Dec 1969. Contract AT(40-1)-2847. 68p. Dep. CFSTI.

Data and information are presented on the fabrication and mechanical properties of stainless steel-uranium dioxide and stainless steel-uranium nitride fuel dispersions. (J.R.D.)

10143 (KFK-1049) PREPARATION OF URANIUM MONONITRIDE PELLETS OF DIFFERING DENSITIES BY COLD PRESSING AND SINTERING. Siebmanns, W. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Material- und Festkoerperforschung). Sep 1969. 21p. (In German). Dep. CFSTI (U. S. Sales Only).

It is possible to remove the sintering difficulties of uranium mononitride by using a fine powder of particle size of approximately 1 to 6 μm protected against oxidation; thus avoiding a complicated technique in very pure inert gas, as well as extremely high sintering temperatures. It is important to have the correct medium particle size, but even more so, to have a convenient choice of particle distribution. UN pellets of 95% theoretical density (TD) whose only impurity was uranium dioxide, were made by cold pressing in air and sintering in nitrogen. Pellet densities of 85 to 90% TD at 1700 to 1800°C and sintering times of 6 to 12 hrs can be obtained. Homogeneous pellets of low density can be obtained by adding uranium sesquinitride. (auth)

10144 (ORNL-tr-2274) METHOD OF PREPARING CALCINED POLLUCITE. Olombel, Andre; Perebaskine, Cecile; Raggenbass, Andre. Translated by S. J. Rimshaw (Oak Ridge National Lab., Tenn.), from French Patent 1,478,340. 4p. Dep. CFSTI.

A procedure of preparing calcined pollucite characterized by the successive steps of mixing a colloidal silica solution and solutions of cesium and aluminum in stoichiometric quantities, evaporating the mixture to dryness with agitation, heating to a temperature below 1000°C, compressing, and calcining at a temperature on the order of 1600°C is summarized. The cesium and aluminum salts which are used are the nitrates. The evaporation and thermal treatment steps may be followed by a sizing step. Pressing takes place at a pressure of the order of 2500 bars. (auth)

10145 (PNCT-AR-68) ANNUAL REPORT OF TOKAI WORKS, APRIL 1, 1968-MARCH 31, 1969. (Power Reactor and Nuclear Fuel Development Corp., Tokai (Japan)). Nov 1969. 89p. Dep. CFSTI (U. S. Sales Only).

The development of nuclear fuels, including mixed uranium and plutonium oxide fuels, for fast breeder reactors and advanced thermal reactors and the development of spent fuel reprocessing technology and related research work are reported. Research on the preparation and properties of UC and UO_2 and materials for cladding for these fuels is discussed. Studies in plutonium fuel design, preparation, and testing are described. Methods for inspecting reactor fuel assemblies and health and safety studies on plutonium contamination are included. (L.C.L.)

10146 INVESTIGATION OF TITANIUM CARBIDE AND ZIRCONIUM CARBIDE FORMATION PROCESSES IN THE REDUCTION OF CHLORIDES BY HYDROGEN ON A GRAPHITE BASE. Ambartsumyan, R. S.; Babich, B. N. Izv. Akad. Nauk SSSR, Neorg. Mater.; 5: 301-4(Feb 1969). (In Russian).

The influence of temperature and the concentration of chlorides in the mixture with hydrogen on the rate of increase of precipitates from the carbides of titanium and zirconium were studied. The rate of carbide precipitate formation was not limited by the diffusion of carbon from the base, but was determined by the rate of the adsorptive-catalytic reactions of reduction of the chlorides by hydrogen. The rate of precipitation of carbides as observed, corresponded to the transition from first to zero order of reactions according to the concentration of chloride. Equations are given for the temperature relation of rates of precipitation in the field of zero order of reactions. (tr-auth)

10147 A PROCESS FOR THE PRODUCTION OF COATED CARBIDIC OR OXIDIC NUCLEAR FUEL OR FERTILE MATERIAL PARTICLES. (to Nuklear-Chemie Und Metallurgie Gesellschaft mbH). British Patent 1,174,268. 17 Dec 1969. Priority date 10 Dec 1965, Germany.

A process for the production of particulate oxide or carbide fuels coated with carbon is described. The green oxide fuels which contain carbon are reacted to form carbides then sintered and coated in heat-treatment furnaces. The oxide particles are coated similarly. Only one fluidized bed furnace is required for the process. (J.R.D.)

10148 INTERACTION OF POWDERS OF ZIRCONIUM CARBIDE AND SILICON. Kosolapova, T. Ya.; Kutysheva, E. V. (Inst. of Problems in Material Studies, Kiev). Porosh. Met., Akad. Nauk Ukr. SSR; No. 11, 61-5(Nov 1969). (In Russian).

The interaction of powders of zirconium carbide and silicon was studied at 800 to 1700°C. It is established that reaction begins at 1000°C. Silicon carbide and zirconium silicide are the products of the reaction. The formation of zirconium mono- or disilicide is determined by the silicon content in the initial charge and the temperature of the process. (auth)

10149 PROCESS FOR THE PREPARATION OF FINE-SIZED ZIRCONIA POWDERS. (to W. R. Grace and Co.). British Patent 1,177,596. 14 Jan 1970. Priority date 7 Jul 1967, United States.

A method is described for preparation of cubic phase stable sub-micron size zirconium dioxide powder. The powder is prepared by thermally decomposing or dehydrating a mixture of zirconium oxide precursor and the precursor of a stabilizing oxide. The stabilizing mixture is composed of ions of Mg, Y, Ca, Ce, or mixed rare earths as nitrates, acetates, carbonates, or hydrous oxides. The product is sinterable to high density. (J.R.D.)

10150 PROCESS FOR THE FABRICATION OF FUEL ELEMENTS FOR NUCLEAR REACTORS AND FUEL ELEMENTS THUS OBTAINED. Blum, P.; Bochirol, L.; Moreau, C. (to Commissariat a l'Energie Atomique). Canadian Patent 827,610. 18 Nov 1969.

Spherical shaped elements designed for use in high temperature

gas-cooled reactors of the pebble bed type are described. The successive fabrication steps consist in preparing a fuel kernel by molding a plastic paste obtained by adding to a powder of refractory material a binding agent which is chemically compatible with it. After shaping and drying the paste, the fuel kernel is impregnated with gaseous hydrocarbons at a temperature of 800 to 1000°C. The fuel kernel is next coated with graphite paste which is also impregnated with gaseous hydrocarbons at 800 to 1000°C. Next, the coated fuel kernel is inserted within a recess having a shape identical with that of the kernel and formed into a graphite ball. Fission gases are thus absorbed in the porous body just described and do not contaminate the coolant gas. The ratio of crushing strength of the fuel kernel to that of the jacket is 1.5:1 or greater which facilitates later re-processing of the fuel. (F.S.A.)

10151 CERAMIC TECHNOLOGY NEEDS FOR THE U. S. ADVANCED REACTORS PROGRAM. Shaw, Milton (Atomic Energy Commission, Washington, D. C.). pp 9-15 of Ceramic Nuclear Fuels. /Kruger, Owen L. (ed.). Columbus, Ohio; American Ceramic Society, Inc. (1969).

From 71st Annual Meeting of the American Ceramic Society, Washington, D. C. See CONF-690512.

Development status and projections for ceramic fuels are reviewed. Emphasis is centered on efforts devoted to development of low cost fuel cycles by production of safe, reliable, and economically competitive fuels. Information is included on properties and present development of ceramic oxide fuels, problems and unknowns of UO_2–PuO_2 fuels, uses of ceramic fuels in the LMFBR program, and other potential uses of ceramic fuels. Discussions are included concerning the role of various organizations and research personnel in development of these fuels. (J.R.D.)

10152 THE PREPARATION AND FABRICATION OF CARBIDES: A REVIEW OF UNITED KINGDOM EXPERIENCE. Parkinson, N. (United Kingdom Atomic Energy Authority, Thurso, Eng.); Russell, L. E. pp 51-9 of Ceramic Nuclear Fuels. /Kruger, Owen L. (ed.). Columbus, Ohio; American Ceramic Society, Inc. (1969).

From 71st Annual Meeting of the American Ceramic Society, Washington, D. C. See CONF-690512.

The preparation and fabrication of near stoichiometric (<5% MC_2/M_2C_3) and hyperstoichiometric (20% MC_2/M_2C_3) carbides as high density pellets or granules, suitable for use in nuclear fuel elements, is described. Attention is concentrated on the route involving carbothermic reduction of oxide, followed by comminution, cold pressing, and sintering. The influence of chemical composition, milling procedures, binders for granulation, sintering aids, and handling procedures is related to the quality of the product in terms of composition control, microstructural features, and bulk density. (auth)

10153 PREPARATION STUDY ON URANIUM MONOCARBIDE COMPACTS. Takahashi, Shuichiro; Maruya, Kazuo (Mitsubishi Atomic Power Industries, Inc., Ohmiya, Japan). pp 60-81 of Ceramic Nuclear Fuels. /Kruger, Owen L. (ed.). Columbus, Ohio; American Ceramic Society, Inc. (1969).

From 71st Annual Meeting of the American Ceramic Society, Washington, D. C. See CONF-690512.

Studies on UC compacts were performed by the addition of the metallic elements W, Mo, Ta, Nb, V, Ti, Zr, Cr, Mn or Fe, and their carbides, and by using high pressure impaction forming and conventional sintering methods. Dense UC compacts of up to about 97% TD were obtained by high pressure impaction forming with 25 ~ 30 k-bar at 1200°C. The hyperstoichiometric UC specimens in which metallic elements were added were devoid of UC_2. Additive metals were converted to carbides and the added carbides carburized metallic uranium in hypo-UC to stoichiometric UC upon impaction and heating. Iron-group elements accelerated the sintering rate of UC. In consideration of the expected conditions to which UC would be subjected in actual use as FBR fuel, the behavior of additives was discussed. (auth)

10154 HIGH PRESSURE SYNTHESIS OF THORIUM SESQUICARBIDE: A NEW ACTINIDE CARBIDE. Krupka, M. C. (Los Alamos Scientific Lab., N. Mex.). J. Less-Common Metals; 20: 135-40(Feb 1970).

Thorium sesquicarbide, having the body-centered cubic Pu_2C_3-type structure, was synthesized by high pressure–high temperature techniques. A minimal pressure and temperature of approximately 30 kb and 1200°C were required to produce the compound in high yield. Lattice parameter measurements suggested a narrow range of homogeneity. High temperature–ambient pressure annealing resulted in the destruction of the body-centered cubic structure. The Vegard relationship in the body-centered cubic high pressure–high temperature yttrium–thorium sesquicarbide system is illustrated. (auth)

Properties Evaluations

Refer also to abstracts 9505, 9597, 10032, 10039, 10052, 10069, 10142, 10192, 10631, 10632, 10639, and 11159.

10155 (BNWL-1200-1, pp 7.1-11) OXYGEN-SENSING SOLID ELECTROLYTES. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

High density, single phase 0.71 ThO_2–0.29 $YO_{1.5}$ solid electrolyte samples of high purity have been successfully fabricated. These samples are entirely single phase with no evidence of high yttria or Al_2O_3 second phases at grain boundaries. Exposure to sodium at 800°C for 100 hr showed no evidence of chemical attack or thermal shock. An acoustical emission technique was employed to evaluate the thermal shock of the commercially fabricated electrolytes. Failure apparently results from circumferential cracks related to thermal shock. Some evidence of attack by sodium was seen at about 500°C. Additional electrolyte tubes, which have failed in sodium while in use in the electrochemical oxygen meter, have been received for characterization and evaluation. (auth)

10156 (GEAP-10054) COMPRESSIVE CREEP CHARACTERISTICS OF STOICHIOMETRIC URANIUM DIOXIDE. Bohaboy, P. E.; Asamoto, R. R.; Conti, A. E. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Development Operation). May 1969. Contract AT(04-3)-189. 52p. Dep. CFSTI.

The creep of cold-pressed and sintered stoichiometric uranium dioxide was measured in compression as a function of temperature, stress, grain size, and theoretical density. The creep rate of uranium dioxide as a function of these parameters is described by a modified Arrhenius equation. The strain rate of uranium dioxide was found to be inversely proportional to the square of the grain size at low stresses and inversely related to the density. The experimental results fit the modified Arrhenius equation within ±32% at a confidence level of 90%. This type of behavior of uranium dioxide is in agreement with existing theoretical descriptions of creep mechanisms, and the correlation indicates that thermally activated creep in uranium dioxide results from a combination of stress-enhanced diffusion, dislocation motion, and sliding at grain boundaries. The mechanism which dominates and controls the creep rate is dependent on the specific temperature, stress, grain size, and density. Activation energies for uranium dioxide creep were calculated to be 90 kcal/mole in the low stress regions and 132 kcal/mole in the high stress regions. Data previously reported on the creep of uranium dioxide agreed well with the results of this investigation. The effects of density and grain size on the creep behavior or uranium dioxide were evaluated and the relations of these material parameters to nuclear fuel element design were discussed. (auth)

10157 (GEAP-13515) MELTING POINT OF PLUTONIA–URANIA MIXED OXIDES IRRADIATED TO HIGH BURNUP. Krankota, J. L.; Craig, C. N. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Development Operation). Jul 1969. Contract AT(04-3)-189. 52p. Dep. CFSTI.

The melting points of stoichiometric and hypostoichiometric mixed oxide fuels irradiated to burnups up to 200,000 MWd/te were measured using a tungsten V-filament furnace in an atmosphere of helium under 10 psig pressure. The melting point of $(Pu_{0.25}U_{0.75})O_{2.00}$ was observed to decrease approximately 80°C at 200,000 MWd/te. The melting point of $(Pu_{0.2}U_{0.8})O_{2.00}$ decreased negligibly at 80,000 MWd/te. (auth)

10158 (GEMP-715) AN INTERIM REPORT ON A ROUND ROBIN EXPERIMENTAL PROGRAM TO MEASURE THE THERMAL CONDUCTIVITY OF STOICHIOMETRIC URANIUM DIOXIDE. Conway, J. B.; Feith, A. D. (General Electric Co., Cincinnati, Ohio. Nuclear Systems Programs). Oct 1969. Contract AT(40-1)-2847. 76p. Dep. CFSTI.

Seven different laboratories were involved in measuring either the thermal conductivity or the thermal diffusivity of high density, stoichiometric UO_2 (O/U 2.002 to 2.007) using material obtained from a single source. Three experimenters used laser-flash type diffusivity measurements, one employed a radial diffusivity technique, and three experimenters used an approach based on steady-state radial heat flow. The results of these studies indicate that the thermal conductivity of UO_2 reaches a minimum value of approximately 0.022 watt/cm °C at 1600 to 1700°C and then increases to approximately 0.034 watt/cm °C at 2500°C; the low temperature values (RT to 1400°C) agree favorably with the values recommended by the IAEA panel which convened in April, 1965. (auth)

10159 (KFK-1062) MEASUREMENT OF THE HEAT CURRENT FUNCTION OF SEVERAL CARBON AND GRAPHITE FELTS. Reiss, F. E. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). Oct 1969. 20p. (In German). Dep. CFSTI (U. S. Sales Only).

The heat current functions of commercially available carbon- and graphite-felts in vacuo were measured. The method and apparatus employed are described. Resulting data of eight different felts are shown graphically. Numerical equations to evaluate heat current function and thermal conductivity of the felts are given. (auth)

10160 (ORO-3508-5) DIFFUSION OF GASES IN SOLIDS. Annual Progress Report, November 1, 1968-October 31, 1969. Elleman, Thomas S.; Ong, Andres Sy; Mears, Luther D. (North Carolina State Univ., Raleigh. Dept. of Nuclear Engineering). 1 Nov 1969. Contract AT(40-1)-3508. 59p. Dep. CFSTI.

The diffusion of ^{133}Xe in ^{131}I doped and fission recoil doped single crystals of KI and RbI was studied. The diffusion coefficients over the temperature range 150 to 500°C were satisfactorily represented by: $D = D_0 e^{-Q/kT}$ where $D_0 = 0.0832^{+3.}_{-.08}$ cm²/sec (RbI) and $1.49^{+3.}_{-.44}$ cm²/sec (KI); $Q = 0.93 \pm 0.05$ eV (RbI) and 1.03 ± 0.05 eV (KI). These diffusion coefficients were both in good agreement with previously measured values for CsI. A change from rock salt (RbI and KI) to body centered cubic structures (CsI) in alkali halides therefore does not result in a pronounced change in rare gas diffusion behavior. Variations in the diffusion coefficients which resulted from clustering of rare gas atoms were detected in KI crystals at concentrations as low as 10^{-3} ppM. A comparison of all experimental results with several possible diffusion models indicated that the model most consistent with all data involved the association of diffusing rare gas atoms with mobile defect clusters. Experiments to identify surface effects on the release of ^{133}Xe from fission recoil injected single crystals of CaF_2 and CsI were carried out. It was observed that surface strains from mechanical polishing, surface evaporation, and surface chemical reactions could all produce anomalous gas release behavior. These effects could be falsely interpreted as arising from bulk trapping processes within the crystal lattice if the true nature of the effect were not identified. Preliminary experiments on the diffusion of tritium in fuel element claddings were performed. (auth)

10161 SOME PHYSICAL PROPERTIES OF CARBIDES OF CERIUM, LANTHANUM, NEODYMIUM, AND YTTRIUM. Paderno, Yu. B.; Yupko, V. L.; Makarenko, G. N. (Inst. of Problems in Material Studies, Kiev). Izv. Akad. Nauk SSSR, Neorg. Mater.; 5: 386-8(Feb 1969). (In Russian).

The Hall Effect at room temperature, the temperature and specific electric resistance relationship, the coefficient of thermal emf, and the thermal expansion at 20 to 1000°C were studied for Ce_2C_3, L_2C_3, Nd_2C_3, and Y_2C_3. The melting points were also measured. (tr-auth)

10162 METHOD FOR DETERMINING THE HEAT TREATMENT TEMPERATURE OF CARBON AND GRAPHITE. Sato, Sennouke; Honda, Toshio; Ito, Hisanori (to Japan Atomic Energy Research Inst.). British Patent 1,177,139. 7 Jan 1970. Priority date 8 Jun 1966, Japan.

A method is given to determine the graphitization temperature which involves the measurement of electrical properties, and employs the thermoelectric power of soft carbon (conventional artificial graphite) and hard carbon (charcoal, sugar coal, or glassy carbon) which varies according to the heat treatment temperature of the carbon or graphite. After the parent material (the material to be heat treated) has been molded at about 150°C or has been calcinated, but before it is graphitized, samples are taken of the same composition as the parent material, and heated to various temperatures within the graphitization temperature range. The thermoelectric power of each sample is compared with that of the parent material after graphitization, and the degree of graphitization or the heat treatment temperature of the parent material can be determined. (J.C.W.)

10163 ELECTRICAL PROPERTIES OF HEXABORIDES OF ALKALI- AND RARE-EARTH METALS AT LOW TEMPERATURES. Paderno, Yu. B.; Novikov, V. I.; Garf, E. S. (Inst. of Problems in Material Studies, Kiev). Porosh. Met., Akad. Nauk Ukr. SSR; No. 11, 70-3(Nov 1969). (In Russian).

Results of investigating the specific electroresistivity and thermo- emf of hexaborides of metals at 1.3 to 300°K are presented. Independence of hexaboride properties to the method of their preparation is established, i.e., they exhibit low sensitivity to random admixtures. (auth)

10164 NEW TYPES OF REFRACTORY NUCLEAR FUELS. II. URANIUM CARBONITRIDES. Benadik, A.; Jakesova, L.; Krivy, I. (Inst. of Nuclear Research, Rez, Czech.). Jad. Energ.; 15: 397-404(Dec 1969). (In Czech).

The use of uranium carbonitrides as potential nuclear fuel for new, advanced types of reactors is discussed. Carbonitrides of variable composition were prepared by method of homogenization treatment at 1600°C in vacuo of 10^{-5} Torr. Some of the important physical and physico-chemical properties of carbonitrides were determined and the variability of these properties with composition was investigated. The empirical equation for calculation of the theoretical value of lattice constants was derived; theoretical density, concentration of uranium, and macroscopic thermal neutron absorbtion cross-section were computed. Also chemical reactions of carbonitrides with water, water vapor, and carbon dioxide were investigated and on the basis of kinetic data (rate constants and activation energies) an attempt to elucidate the reaction mechanism was made. Uranium carbonitrides had better stability in water and water vapor than uranium monocarbide. (auth)

10165 DETERMINATION OF THE PARTICLE SIZE DISTRIBUTION IN POWDERS FOR NUCLEAR CERAMIC FUELS. Jitea, I. (Inst. of Atomic Physics, Bucharest). Stud. Cercet. Fiz.; 21: 991-1000(1969). (In Rumanian).

A sedimentation method for determining the particle size distribution in powders used for nuclear ceramic fuels is described. The powder in the subsieve range was dispersed in a suitable liquid and the particles were allowed to settle on the special pan adopted at an analytic balance. The sedimentation and the grain size distribution curves were plotted. The measured particle size ranged from 40 to 2 μm during 30 minutes and the experimental relative error was ±1%. (auth)

10166 ELECTROPHYSICAL PROPERTIES OF MELTED HEXABORIDES OF ALKALINE- AND RARE-EARTH METALS. Paderno, Yu. B.; Garf, E. S.; Nemyskii, T.; Pratska, I. (Inst. of Problems of Material Management, Kiev). Porosh. Met., Akad. Nauk Ukr. SSR; No. 10, 55-8(Oct 1969). (In Russian).

The temperature dependence of the resistivity and coefficients of thermal emf of some metal hexaborides was investigated. The conclusions were based on the physical nature of the materials under investigation. (auth)

10167 OXIDE FUEL TRENDS. Bupp, L. P. (Oregon State Univ., Corvallis); Evans, E. A. pp 16-24 of Ceramic Nuclear Fuels. /Kruger, Owen L. (ed.). Columbus, Ohio; American Ceramic Society, Inc. (1969).

From 71st Annual Meeting of the American Ceramic Society, Washington, D. C. See CONF-690512.

Present development, production, and irradiation of oxide fuels for nuclear power reactors involves more fuel suppliers and increased production of U-, Pu- and Th-oxide bearing fuel elements; automated plants; and intensified efforts on quality assurance, including breakthroughs in materials characterization, standardization, and knowledge of in-reactor conditions. Approximately two million irradiated elements are currently on hand, including some tested to and beyond performance limits. More effective post-irradiation examination equipment and methods have recently been developed along with meaningful fuel cycle costs from increasingly competitive markets involving fuels with unique handling problems, nuclear characteristics, and irradiation behavior. Difficulties will be encountered for several years with fuels designed for high power density-long life-time operation, because many of the developments have not been focused on fuels now fabricated. The trend, however, is toward an increasingly commanding lead by oxide fuels, with a better understanding of their ultimate potential for safe economic power production in most reactors. (auth)

10168 ANALYSIS OF A SIMULATION OF IRRADIATED $(U,Pu)O_2$. Schmitz, Franz (CEA, Fontenay-aux-Roses, France). pp 32-7 of Ceramic Nuclear Fuels. /Kruger, Owen L. (ed.). Columbus, Ohio; American Ceramic Society, Inc. (1969).

From 71st Annual Meeting of the American Ceramic Society, Washington, D. C. See CONF-690512.

The post irradiation state of U, Pu mixed oxide nuclear fuel at 2% burnup has been simulated by mixing $(U,Pu)O_2$ with 25 inactive fission product elements. By sintering, dense pellets were obtained with a microstructure showing the grey matrix of $(U,Pu)O_2$ and shiny white inclusions of spherical shape. This microstructure is quite similar to the microstructure which is found in the colder regions of irradiated oxide fuels. The stoichiometry of the simulated fuel has been measured and the oxygen pick-up by metallic fission products has been evaluated. The lattice constants obtained from x-ray analysis of the final product could be explained quantitatively by the stoichiometric changes and the dissolution of soluble fission products in the matrix. The metallic inclusions as well as

the matrix and a grey phase have been examined using a microprobe analyzer. (auth)

10169 ELASTIC BEHAVIOR OF URANIUM DIOXIDE. Marlowe, M. O.; Kaznoff, A. I. (General Electric Co., Pleasanton, Calif.). pp 90-9 of Ceramic Nuclear Fuels. /Kruger, Owen L. (ed.). Columbus, Ohio; American Ceramic Society, Inc. (1969).

From 71st Annual Meeting of the American Ceramic Society, Washington, D. C. See CONF-690512.

Young's modulus and shear modulus of elasticity of polycrystalline UO_2 were determined by the sonic resonant frequency technique. The effect of porosity, simulated solid fission products, and temperature on these moduli were investigated. The moduli were linearly related to porosity. The addition of simulated solid fission products to the 6% level or addition of 1% gadolinium oxide did not significantly alter the elastic moduli. These dopants did extend the maximum temperature of measurement with this technique to 1780°C rather than 1250°C for undoped material. This extension of temperature was attributed to inhibition of grain boundary slip by the dopants. Gruniesen's constant and Debye characteristic temperature were determined as a function of temperature for UO_2. (auth)

Structure and Phase Studies

Refer also to abstracts 9304, 10089, 10091, 10096, and 10203.

10170 (ANL-Trans-791) THERMODYNAMICS OF OXYGEN AND NITROGEN DISSOLUTION IN URANIUM MONOCARBIDE. Alcock, C. B.; Javed, N. A.; Steele, B. C. H. Translated for Argonne National Lab., Ill., from Bull. Soc. Fr. Ceram.; No. 77, 99-108(1967). 16p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 23: 1052.

10171 (LA-4295) GENERATION OF α-SiC STACKING SEQUENCES. Roof, R. B. Jr.; Bivins, R. L. (Los Alamos Scientific Lab., N. Mex.). 17 Oct 1969. Contract W-7405-eng-36. 83p. Dep. CFSTI

α-SiC crystal structures are polymorphs, usually consisting of 2-, 3-, and 4-layer blocks arranged in a stacking sequence so as to yield a specific number of layers in a hexagonal unit cell. The combination of these blocks into crystallographically significant sequences representing crystal structures has been accomplished through use of a computer program. Tables of these sequences are listed as a function of layer number. (auth)

10172 (RD/B/N-1450) COALESCENCE OF DISLOCATION LOOPS BY SELF CLIMB. Turnbull, J. A. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Nov 1969. 19p. Dep. CFSTI.

During an isothermal anneal of an ion bombarded UO_2 thin foil, electron microscope observations were made of the self climb velocity of dislocation loops prior to coalescence. A model for loop movement by self climb was constructed and two driving forces were considered. First, the mutual interaction of the loop strain fields, and second, the interaction between loops and individual vacancies. In the case of UO_2 the former predominates, but for metals both interactions are of similar magnitude. The model predicts that the loops remain circular during the climb process and that the velocity is rate controlled by the pipe diffusion coefficient at any particular temperature. (auth)

10173 STRUCTURAL INVESTIGATIONS ON HARD METALS. Grewe, Hans. Prakt. Metallog.; 6: 411-19(Jul 1969). (In German and English).

Structural investigations of hard metal alloys are discussed. Assessment of fractures and porosity, and metallographic structure investigation in particular are described. When the results of the structural investigation in context allow conclusions to be drawn about other important properties, this is briefly indicated. The assessment of porosity and grain size of hard metal alloys using new ASTM manuals is discussed. (auth)

10174 ON THE INVESTIGATION OF THE VANADIUM PENTOXIDE–ZINC OXIDE SYSTEM. Viting, L. M.; Gorbovskaya, G. P. Vestn. Mosk. Univ., Ser. II. Khim.; No. 5, 102-3(Sep-Oct 1969). (In Russian).

The phase diagram for the vanadium pentoxide–zinc oxide system was obtained by thermal and microstructural method in the range of 45 to 82 mole% ZnO. (auth)

10175 THE CRYSTAL STRUCTURE OF Ta_2VC_2. Rudy, E. (Oregon Graduate Center, Beaverton). J. Less-Common Metals; 20: 49-55(Jan 1970).

The crystal structure of Ta_2VC_2 was determined from x-ray powder photographs. The structure is trigonal, space group D^5_{3d}-R$\bar{3}$m, with a rhombohedral unit cell of a_R = 7.481 Å, α = 23° 27′ (hexagonal axes a = 3.045 Å, c = 21.81 Å). The unit cell contains 9 close packed metal layers in stacking sequence $(hhc)_3$, or ABABCBCAC. The metal atoms were statistically distributed among point positions 3(a) and 6(c). It was not possible to decide by x-ray diffraction whether the carbon atoms were randomly distributed among the 9 octahedral interstitial sites in 6(c) and 3(b), or whether an ordered sublattice structure was formed. The phase was stable from room temperature to above 2600°C. The homogeneity range at 1650°C varied between the limits $(Ta_{1.80\ to\ 2.04}, V_{1.20\ to\ 0.96})C_{1.74\ to\ 1.80}$; the phase was thus substantially deficient in carbon. (auth)

10176 STRUCTURE, PROPERTIES, AND PREPARATION OF PEROVSKITE-TYPE COMPOUNDS. Galasso, F. S. International Series of Monographs in Solid State Physics. Vol. 5. Oxford; Pergamon Press (1969). 217p. 70s.

Sections are included on the superconducting properties of these compounds, on thermoelectric properties, and on the effects of irradiation. (UK)

10177 X-RAY INVESTIGATION OF THE RHENIUM–MANGANESE–BORON SYSTEM. Telegus, V. S.; Kuzma, Yu. B. (Lvov State Univ.). Dopov. Akad. Nauk Ukr. RSR, Ser. A; No. 10, 945-8(Oct 1969). (In Ukrainian).

The Re–Mn–B system was investigated by x-ray analysis. The existence of the τ-phase was confirmed (the structure of the $Cr_{21}W_2C_6$ type) and the homogeneity range was established (20.7 at. % B, 15 to 50 at. % Re, a = 10.851 – 11.307 Å). The new compound Re_3MnB_2 with a narrow homogeneity range and the orthorhombic structure of the Mg_2Cu type (a = 15.38 ± 0.01 Å, b = 7.832 ± 0.05 Å, c = 4.458 ± 0.003 Å) was found. The solubility of Re in Mn_2B is 47 at. %, in MnB – 25 at. %. The borides Re_3B and Re_7B_3 dissolve ~5 at. % Mn. The solubility of the third component in other borides of Mn and Re is insignificant. The boride MnB_2 is decomposed at 800°C to Mn_3B_4 and MnB_4. (auth)

10178 CRYSTAL STRUCTURE OF $CeCo_3B_2$ AND ANALOGOUS COMPOUNDS. Kuzma, Yu. B.; Kripyakevich, P. I.; Bilonizhko, N. S. (Lvov State Univ.). Dopov. Akad. Nauk Ukr. RSR, Ser. A; No, 10, 939-41(Oct 1969). (In Ukrainian).

The compounds RCo_3B_2 (R = Ce, Sm, Gd, Tb, Dy, Ho, Er, Tm, Lu, Y, Sc) with a new type of structure ($CaCu_5$ superstructure with strongly diminished c/a) were found by means of x-ray diffraction analysis. The lattice periods of $CeCo_3B_2$ were a = 5.067 Å, c = 3.036 Å, c/a = 0.600; the atoms have the following positions (space group R6/mmm-D^1_{6h}): 1 Ce in 1 (a) 000, 3 Co in 3 (g) ½0½, 2 B in 2 (c) ⅓ ⅔ 0. (auth)

10179 PHASE EQUILIBRIA IN THE Mo–TiC–Ti REGION OF THE TERNARY SYSTEM Mo–Ti–C. CHARACTER OF ALLOY CRYSTALLIZATION AND PROJECTION OF SOLIDUS SURFACE. COMMUNICATION I. Eremenko, V. N.; Velikanova, T. Ya. (Kiev State Univ.). Porosh. Met., Akad. Nauk Ukr. SSR; No. 11, 82-8(Nov 1969). (In Russian).

By using metallographic and roentgen phase analyses, the character of alloy crystallization in the system Mo–TiC–Ti as well as the phase equilibria on the solidus surface were investigated. It is shown that the continuous transition of the congruent character of crystallization of alloys into incongruent one occurs in the investigated region. The temperature of the transitional conode triangle is 2165°C. Direction of conodes on the solidus surface in the two-phase region formed by the cubic carbide and metallic solid solution is parallel to the section Mo–TiC of the ternary system Mo–Ti–C in a wide composition range of the carbide and metal phases. (auth)

10180 ON INTERACTION OF ZIRCONIUM WITH TRANSITION METALS AND BORON. Voroshilov, Yu. V.; Kuzma, Yu. B. (Lvov State Univ.). Porosh. Met., Akad. Nauk Ukr. SSR; No. 11, 94-8(Nov 1969). (In Russian).

The systems Zr–Ti–B and Hf–Zr–B were investigated by means of x-ray diffraction. The phase equilibria were established at 1500°C. The systems Zr–Me–B, where Me is Ti, Hf, V, Nb, Ta, Cr, Mo, W, Mn, Re, Fe, Co, Ni are compared. The crystal structure of the compounds $ZrCo_3B$ and $HfCo_3B$ belongs to a new structure type (hexagonal system, 45 atoms in the unit cell; for Zr compounds a = 8.418; c = 9.132 Å; for Hf compound a = 8.38; c = 9.12 Å). Thermodynamic calculations of ΔZ support experimental equilibria in the investigated systems. (auth)

10181 THE METASTABLE τ-PHASE IN THE IRON–NICKEL–BORON SYSTEM. Stadelmaier, Hans H.; Pollock, Charles B. (North Carolina State Univ., Raleigh). Z. Metallk.; 60: 960-1 (Dec. 1969). (In German).

In the ternary system iron–nickel–boron a metastable boride

$Fe_3Ni_{20}B_6$ with the $D8_4$ structure type solidified from the melt. Its lattice constant is 10.501 Å. The complete miscibility between Fe_2B and Ni_2B as well as the solubility of 45 at.% Fe in Ni_3B at 800°C were confirmed. (auth)

10182 INVESTIGATION OF THE SYSTEM UMo_2O_8–UW_2O_8. Rozanova, O. N.; Kovba, L. M.; Trunov, V. K. Radiokhimiya; 11: 463-5(1969). (In Russian).

Investigations were made of the binary section, UMo_2O_8–UM_2O_8, of the ternary system UO_2–MoO_3–WO_3 using x-ray analysis at 850 to 1000°C. The existence of a region of solid solutions of uranium tungstate in α-UMo_2O_8 was established. Uranium tungstate at 900°C dissolves about 5% of the uranium molybdate. (M.C.G.)

10183 PHASE COMPOSITION AND SOME PROPERTIES OF ALLOYS OF THE SYSTEM MOLYBDENUM–CHROMIUM–BORON. Kolomytsev, P. T.; Moskaleva, N. V.; Snetkov, A. Ya. (Air Force Engineering Academy, Moscow). Porosh. Met., Akad. Nauk Ukr. SSR; No. 10, 76-81(Oct 1969). (In Russian).

The structure of alloys, containing up to 50 at. % of boron at temperature 1000°C was investigated. Powdered molybdenum (99.7%), refined chromium (99.94%), and amorphous boron (99.8%) were used to prepare the alloys. An isothermal section of the phase diagram was constructed by metallographic methods, roentgenostructural analyses, and microhardness measurement. The following phases were determined: α-solid solutions of chromium and molybdenum, η–on the Cr_2B base, δ–on the Cr_5B_3 base, ϵ–on the CrB base, β–on the base of Mo_2B, γ–on the base of γ-MoB, and ternary boride phase T of the variable composition of Me_2B type. The field of ternary phase distribution extends from 20 to 48 at. % of Mo and 33 to 34 at. % of B. (auth)

10184 X-RAY DIFFRACTION INVESTIGATION OF THE Ti–Ni–B, Mo–Ni–B, AND W–Ni–B SYSTEMS. Kuz'ma, Yu. B.; Chepiga, M. V. (Lvov State Univ.). Porosh. Met., Akad. Nauk Ukr. SSR; No. 10, 71-5(Oct 1969). (In Russian).

The Ti–Ni–B, Mo–Ni–B and W–Ni–B systems were investigated by x-ray analysis and the phase equilibria were established at 800°C. Compounds (Y-phases) with unknown structure were found in the Mo–Ni–B and W–Ni–B systems. (auth)

10185 PHASE STUDIES AND FUEL PERFORMANCE IN THE SYSTEM Pu–U–O. Koizumi, Masumichi; Nakamura, Yasuji (Power Reactor and Nuclear Fuel Development Corp., Tokai, Japan). pp 25-31 of Ceramic Nuclear Fuels. /Kruger, Owen L. (ed.). Columbus, Ohio; American Ceramic Society, Inc. (1969).

From 71st Annual Meeting of the American Ceramic Society, Washington, D. C. See CONF-690512.

Phase studies on $(Pu_y, U_{1-y})O_{2-x}$ were carried out by DTA (25 to 800°C) and x-ray diffraction (25°C) to confirm the lower limit of Pu content of two phase separation. Y values were 0.17 to 0.40 and stoichiometry was controlled between 2.00 and 1.92. The limit for the phase boundary between the single fcc phase and two fcc phases was estimated to be about 20% Pu. Phase changes were observed in DTA curves to proceed slowly and thermal expansion measurements during the phase change did not indicate any sharp breaks but, rather smoothly expanding curves. (auth)

10186 PRESENT STATUS OF THE URANIUM–PLUTONIUM–CARBON PHASE DIAGRAM. Leary, J. A. (Los Alamos Scientific Lab., N. Mex.). pp 38-50 of Ceramic Nuclear Fuels. /Kruger, Owen L. (ed.). Columbus, Ohio; American Ceramic Society, Inc. (1969).

From 71st Annual Meeting of the American Ceramic Society, Washington, D. C. See CONF-690512.

The ternary system composed of C–Pu–U is not fully defined, however, some areas have been investigated. Results of these investigations are summarized by presenting data and information on the binary systems that make up the ternary diagrams. (J.R.D.)

10187 PHASE RELATIONSHIP IN THE U–C–V SYSTEM AND INTERACTION OF BUFFERED CARBIDES WITH AUSTENITIC AND FERRITIC STAINLESS STEELS. Huet, J.-J.; Casteels, F.; Cools, A.; Riels, P.; Dresselaers, J.; Lecocq, R.; Pelsmaekers, J.; Van Asbroeck, Ph.; Vangeel, J. (CEN–SCK, Mol, Belg.). pp 138-46 of Ceramic Nuclear Fuels. /Kruger, Owen L. (ed.). Columbus, Ohio; American Ceramic Society, Inc. (1969).

From 71st Annual Meeting of the American Ceramic Society, Washington, D. C. See CONF-690512.

To avoid carbon transfer from carbide fuels to the canning materials the carbon activity in uranium monocarbide was buffered with chromium or vanadium. A ternary U–V–C phase diagram was established in the composition range of interest for understanding the compatibility problems. Uranium carbide samples, stabilized with chromium or vanadium, were maintained in contact with AISI 316 and AISI 410 steels for 2 to 16 weeks at 800°C; in each case a sodium bond was used in order to enhance the carbon transfer. Compatibility of these materials was evaluated as a function of the phases, the microstructures, and the elements of importance for the exchange mechanism. (auth)

Radiation Effects

Refer also to abstracts 9414, 9436, 10138, 10214, 10606, 10607, and 11158.

10188 (BMI–1872) PROGRESS ON DEVELOPMENT OF MATERIALS AND TECHNOLOGY FOR ADVANCED REACTORS DURING JULY–SEPTEMBER 1969. Keller, Donald L. (Battelle Memorial Inst., Columbus, Ohio). Oct 1969. Contract W-7405-eng-92. 91p. Dep. CFSTI.

Progress in the development of fuels for advanced reactors is reported in three sections. A separate abstract was prepared for each section. (J.R.D.)

For abstracts of individual sections see: 10111, 10138, and 10189.

10189 (BMI–1872, Sect.C) CREEP OF REACTOR FUEL MATERIALS (AEC-RDT, TASK 6, AND ANL). (Battelle Memorial Inst., Columbus, Ohio). 29p.

Results of investigations are reported on fabrication and operation of in-pile fuel creep tests using capsules containing PuO_2–UO_2 fuels. Other work is reported on fabrication and characterization of UO_2–PuO_2 specimens for compressive creep experiments and on effects of stoichiometry on creep in PuO_2–UO_2 fuels. (J.R.D.)

10190 (BMI–1875) PROGRESS ON HIGH-TEMPERATURE FUELS TECHNOLOGY DURING AUGUST–OCTOBER 1969. Quarterly Report, Task 6. Keller, Donald L.; Chubb, Walston (Battelle Memorial Inst., Columbus, Ohio). Nov 1969. Contract W-7405-eng-92. 69p. Dep. CFSTI.

Two tungsten-42 vol % UO_2–28 vol % porosity cermet specimens with 40-mil-thick claddings showed a 7 percent volume decrease at 1640°C at a burnup of 1.7×10^{20} fissions per cm^3. A fission-gas analysis of one of these showed that 80 percent of the fission gas was released. This suggests extraordinary fission-gas mobility at this temperature in this cermet. Two different types of swelling behavior have been observed in UN-base fuels at about 1700°C. One type is characterized by initial swelling rates of the order of 10 to 20 vol % per 10^{20} fissions per cm^3 and a high mobility of fission gases. The second type is characterized by initial swelling rates of the order of 2 to 4 vol % per 10^{20} fissions per cm^3 and a low mobility of fission gases. The effects of interconnected porosity in both types of UN-base fuels seem to be to eliminate the formation of large gas bubbles at grain boundaries by venting the gas that is mobile enough to appear at grain boundaries. The interconnected porosity seems to remain open to a large extent and seems, therefore, to be used to accommodate swelling of UN particles only to a limited extent. A 60 percent dense specimen of crushed, minus 230-mesh particles of UC showed a volume change of 7 percent after a burnup of 2×10^{20} fissions per cm^2 at 1530°C. The result compared favorably with volume increases of about 35 percent at the same burnup at 1680°C in dense UC. A model describing the overlap of spherical bubbles in random array suggests that when fuels have swelled as much as 10 vol % then an increasing rate of gas release can be expected by virtue of increasing interlinkage of bubbles. (auth)

10191 (BNWL–1202) RESEARCH AT BATTELLE-NORTHWEST ON TRANSPORT PROCESSES IN OXIDE NUCLEAR FUEL. Christensen, J. A. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Oct 1969. Contract AT(45-1)-1830. 41p. Dep. CFSTI.

Studies of transport in fuels to coordinate precision laboratory measurements with in-pile experiments are reported. Results are applied to fuel systems design and behavioral model development. Emphasis has been on mixed uranium-plutonium oxides with lesser efforts on UO_2, mixed nitrides, and uranium oxycarbides. Thermal diffusivities for various fuel materials have been measured at temperatures to 1700°C. Results together with studies of associated thermodynamic properties, melting points, phase equilibria, electrical and thermoelectric properties, and materials synthesis methods, have been applied toward designing and interpreting a variety of irradiation experiments. Included are measurements of stoichiometry and fabrication method effects on in-pile heat transfer in $(U,Pu)O_{2+x}$ and UO_2; determination of stoichiometry and heat rating effects on oxygen, plutonium, and fission fragment distributions in oxide fuels; observations of relations between void and fission fragment distributions and fuel

thermal history; characterization of irradiated mixed-oxide structures in terms of stoichiometry and heat rating; and studies of dimensional stability. (auth)

10192 (GA–9828) RESEARCH ON GRAPHITE. Quarterly Progress Report for the Period Ending November 14, 1969. Engle, G. B.; Bokros, J. C.; Price, R. J. (Gulf General Atomic, Inc., San Diego, Calif.). 20 Nov 1969. Contract AT(04-3)-167. 24p. Dep. CFSTI.

Calcined cokes are being separated in a densitometer and heat treated to determine the effect of the calcined particle density on the graphitizability of the structure. Attempts were made to separate a pyrolytic carbon impregnant from Poco base stock in the densitometer, but the two materials were too much alike to achieve separation. Aluminum-doped petroleum coke was prepared and formed into carbon compacts with a pitch binder. After heating for 6 hr at 2300°C, up to 73 wt-% of the carbon structure was converted to graphite in the compacts where the original aluminum content was about 17 wt-%. The aluminum evolved from the compact during the heat treatment. Two series of graphite specimens are currently under high-temperature irradiation in the Engineering Test Reactor (ETR). The next scheduled capsule discharge date is December 1969. The graphites will have received up to 15×10^{21} n/sq cm (E > 0.18 MeV) at 1000 to 1250°C. Thermal conductivity measurements were made at room temperature on specimens irradiated at 600 to 1200°C. Results of annealing experiments at 1200 to 1700°C indicate a rapid and immediate recovery of a portion of the thermal conductivity degradation, followed by a small recovery after relatively long annealing times. The irradiation of both low-temperature isotropic (LTI) carbons and high-temperature isotropic (HTI) carbons has been extended to fluences of 7×10^{21} n/sq cm (E > 0.18 MeV) at 600 and 900°C. The dimensional changes are now showing deviation from the Bacon relation at 600°C as well as at the higher temperatures. The LTI carbons do not expand volumetrically as rapidly as the HTI carbons, and their enhanced anisotropic behavior is less at high fluences. (auth)

10193 (GEAP–5100-8) HIGH PERFORMANCE UO_2 PROGRAM. DIMENSIONAL CHANGES IN HIGH PERFORMANCE POWDER AND PELLET FUEL RODS: PROFILOMETER STUDIES. Hoffmann, J. P.; Lyons, M. F.; Weidenbaum, B. (General Electric Co., Pleasanton, Calif. Vallecitos Atomic Lab.). Sep 1966. Contract AT(04-3)-189. 68p. (EURAEC–17753). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

The fuel rod dimensional data obtained during the High Performance UO_2 Program have been extensively analyzed and correlated. These data consist of detailed, pre- and post-irradiation micrometer measurements of the diameter and length of every rod irradiated and post-irradiation linear and spiral profilometer traces on selected rods representative of each of the fabrication variations tested. The availability of both types of dimensional measurements on the same rods has provided a direct comparison of the two measurement techniques. The profilometer is a much more sensitive and accurate device and the data are more reproducible and less influenced by operator techniques than those from the micrometer. However, the profilometer measurement is more expensive and time consuming for a single rod examination because of the equipment set-up time. The solid pellet fuel rod swelling data versus thermal performance level have been re-analyzed to determine the UO_2 phase change volume expansion with melting. The analysis is similar to that reported earlier but the more accurate profilometer data, where available, are used and the measured fuel rod length changes are taken into account. The calculated phase change volume increase is 7.4% rather than the 7% reported earlier and is in slightly better agreement with the directly measured value of 9.6%. A quantitative measurement of the severity of pellet interface ridging was developed with the number of ridges per rod and the mean ridge height as parameters. Results of analysis of the data with these parameters indicate that the ridging severity in a specific type of rod, i.e., solid pellet or hollow pellet, increases with increasing thermal performance. The use of hollow pellets reduces ridging severity from that with solid pellets at equivalent thermal performance levels. Ridging is essentially absent in compacted powder fuel rods although there are occasional nonperiodic disturbances in an otherwise smooth profile. The individual ridge severity does not appear to increase beyond the onset of central melting and may actually decrease if over-all cladding swelling occurs. The observed maximum ridge height of about 2.5 mils in these rods is comparable to values measured in high performance rods operated below melting. No adverse effect of ridging on Zircaloy-2 clad performance was noted during these irradiations but the ridge sites are of concern as potential failure points from low cycle fatigue or other stress dependent failure mechanism. One instance of what is believed to be incipient creep collapse of the Zircaloy-2 cladding was observed in a very high performance, high burnup rod. Detectable clad ovality developed over a substantial fraction of the high performance zone in this rod and suggests that cladding support by the pellets is reduced when operating with gross central melting. (auth)

10194 (GEMP–710) IRRADIATION TESTING AND EVALUATION OF REFRACTORY METAL FUEL ELEMENTS OF 710 FAST REACTOR PROGRAM. Final Report. Newsom, D. L.; Collins, J. F. (General Electric Co., Cincinnati, Ohio. Missile and Space Div.). Oct 1969. Contract AT(40-1)-2847. 41p. Dep. CFSTI.

The fuel burnup capability was determined for eighteen refractory-metal clad W–UO_2 cermet fuel specimens irradiated under long-time service conditions characteristic of Brayton Cycle Reactor Systems. Three experiments initiated by the 710 Reactor Systems Program were tested in the Low Intensity Test Reactor (LITR) for times to 13,400 hours at temperatures to 1535°C, incurring fuel burnups to 1.05×10^{20} fissions/cm^3 of cermet. These experiments demonstrated that high density W-alloy-clad W-60UO_2 fuel specimens, fully bonded and not vented, have good dimensional stability and containment of fission products to temperature and burnup levels of 1440°C, 6.7×10^{19} fissions/cm^3 of cermet (1.1×10^{20} fissions/cm^3 of fuel), and to 13,400 hours in time at temperatures as high as 1360°C. At higher temperatures (to 1535°C) and burnup (to 1.05×10^{20} fissions/cm^3 of cermet) blisters developed resulting in cladding rupture and release of fission gases. Efforts to extend the leak-free life and dimensional stability of the fuel specimens by the addition of rhenium to the matrix were not only ineffective but detrimental. Performance capabilities exceeding those required for the 710 Reactor application were demonstrated by these inpile experiments. Furthermore, the results of these tests indicate the W–UO_2 fuel element should be considered for other applications such as lithium- and potassium-cooled SNAP systems, and fast thermionic direct conversion power plants. (auth)

10195 (WAPD-Trans–124) SWELLING IN OXIDE FUELS. Inoue, Kiyoshi. Translated for Bettis Atomic Power Lab., West Mifflin, Pa., from pp 8-12 of 2nd Seminar on Physical Properties of Fast Reactor Fuels, Tokyo, Japan, March 29, 1968. 17p. (CONF-680326–1). Dep. CFSTI.

Fuel swelling is the major design consideration for satisfactory irradiation performance of fast reactor fuels. Information on the oxide fuel swelling is inclined to be limited in available data of Daniel, et. al., (1962) and Skovdahl et al. (1967). However, basic studies on the fuel swelling have been performed by many investigators in each area of physical properties of fuel, fission product behavior, and bubble behavior. Approach to the swelling of oxide fuels is reviewed, and formulas for swelling are introduced. It is noted that the first subject to be done in the future should be the statistical treatment of the available experimental data with the consideration of definite physical meaning, and the irradiation test with emphasis to supply important data for solving swelling equations. (auth)

10196 (WAPD-Trans–125) SWELLING IN CARBIDE FUELS. Watanabe, Hitoshi. Translated for Bettis Atomic Power Lab., West Mifflin, Pa., from pp 13-19 of 2nd Seminar on Physical Properties of Fast Reactor Fuels, Tokyo, Japan, March 29, 1968. 21p. (CONF-680326–2). Dep. CFSTI.

Swelling in carbide fuels induced by fission gas bubbles and solid fission products was reviewed. The swelling caused by migration and coalescence of fission gas bubbles is strongly influenced by the fuel temperature and carbon content. The swelling rate increases with temperatures above around 1,000°C and with the decrease of carbon contents below 4.7–4.8 wt % carbon. The effects of initial density and external stress on the swelling rate remain unknown up to now. The behavior of solid fission products is important at the temperatures up to around 1,000°C, as the fraction of swelling by the solid fission products is larger than by the fission gas bubbles. By summation of the partial volumes associated with the solid fission products and the volume of the matrix non-fissioned, the swelling rate was calculated to be ~0.4% $\Delta V/V$ per 1 at. % burnup, and ~1.3% $\Delta V/V$ per 1 at. % burnup, without and with volatile fission element, respectively. (auth)

10197 MODIFYING SUBMICROPOROSITY BY IRRADIATING GRAPHITE. Churilov, Yu. S.; Virgil'ev, Yu. S. Konstr. Mater. Osn. Grafita; No. 3, 47-54(1967). (In Russian).

Effects of irradiation at 300°C by integral fluxes of 2.10^{21} 3.10^{21}, and 4.10^{21} n/cm^3 on submicroporosity in grade GMZ graphite as determined by acute-angle x-ray scattering was studied. It was shown that in the range of 60 to 1000 Å the combined volume of pores decreased in proportion to increasing irradiation. Raising irradiation temperature to 30°C also decreased pore volume. Submicroporosity in irradiated material was modified under iso-

thermal annealing (1500°C) in proportion to the heating period. The instant annealing began, pores expanded in all dimensions while the lattice parameter reduced to its original (non-irradiated) state. Pore volume then decreased and only gradually increased with time to approximately its original condition. (JPRS)

10198 RADIATION PHENOMENA IN ALUMINUM OXIDE. Bagdasarov, Kh. S.; Vakhidov, Sh. A.; Khaimov-Mal'kov, V. Ya.; Khatamov, D. R.; Yusupov, A. A. (Inst. of Nuclear Physics, Tashkent). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk; No. 5, 38-40(1969). (In Russian).

Radiation effects and the nature of structural defects induced by radiation in pure corundum and in crystals with a small amount of chromium were studied. Photoluminescence and thermoluminescence spectra of specimens irradiated in a reactor and by ^{60}Co γ rays followed by physical treatment were analyzed. It was found that neutron-irradiated corundum crystals containing Al and O formed short-life isotopes $^{28}Al(T_{\frac{1}{2}} = 2.3$ min and $^{19}O(T_{\frac{1}{2}} = 29.4$ sec). Radioinduced changes in corundum's physical properties were studied with specimens irradiated in a VVR-S reactor by 1.8×10^{13} n/cm^2/sec at 39°C and by a γ source by 5000 r/sec at 77 to 400°K. In contrast to the specimens irradiated by neutrons, the specimens exposed to the 5000 r/sec γ rays (within the integral doses up to 10^{10} r) did not show any additional photoluminescence. It was found that the effects of γ radiation, as determined by the strucural defects of crystals, developed by various methods. (R.V.J.)

10199 INVESTIGATION OF AN IRRADIATED HEXAGONAL NITRIDE. Khusidman, M. B.; Neshpor, V. S.; Smirnov, V. M. Radiokhimiya; 11: 477-8(1969). (In Russian).

After irradiation by gamma rays at a dose on the order of 5×10^8 R, the powdery hexagonal nitride of boron, obtained by reactions of boric acid with ammonia, changed from white to a yellowish color and manifested intensive paramagnetic absorption. This absorption was manifested only by powders calcined at 1700°C after production in an Ar atmosphere and rapid cooling. The forms produced at 1200°C and not subjected to further thermal treatment, did not change color after irradiation and did not manifest paramagnetic absorption. The color change and EPR spectra produced by irradiation disappeared after annealing at 1000°C. It was concluded that these changes are caused by vacancies in the sublattice of nitrogen atoms. (tr-auth)

10200 RADIATION STABILITY OF ^{244}Cm AND ^{238}Pu DIOXIDE UNDER SELF-IRRADIATION. Kapshukov, I. I.; Yakovlev, G. N.; Skiba, O. V.; Timofeev, G. A.; Sudakov, L. V. At. Energ. (USSR); 27: 337-8(Oct 1969). (In Russian).

X-ray structural analysis was made of the influence of self-irradiation (at room temperature) on the crystalline lattice parameters of highly active oxides of ^{244}Cm and ^{238}Pu isotopes. A curve of the relative variations in the crystalline lattice parameters of the specimens was constructed as functions of the dose of self-irradiation. (R.V.J.)

10201 LATTICE DEFECTS BY NEUTRON IRRADIATION IN UO_2, UN, AND UC. Dienst, W.; Brucklacher, D. (Kernforschungszentrum, Karlsruhe, Ger.). pp 82-9 of Ceramic Nuclear Fuels. /Kruger, Owen L. (ed.). Columbus, Ohio; American Ceramic Society, Inc. (1969).

From 71st Annual Meeting of the American Ceramic Society, Washington, D. C. See CONF-690512.

Compressed powder samples of UN and UC were irradiated at temperatures below 130°C to fission densities of 6.4×10^{18} f/cm^3. The change of the lattice parameter and local lattice strain (measured by x-ray diffraction peak position and width) with fission density is similar to that reported for UO_2. An early saturation of the lattice-parameter increase between 1×10^{17} and 1×10^{18} f/cm^3, probably caused by interstitial clustering, is then followed by a decrease, possibly due to the further production of isolated or only slightly clustered vacancies. The saturation of the lattice-parameter increase $\Delta a/a$ is accompanied by the beginning of local lattice strain increase. Post-irradiation annealing led to a full recovery of the lattice parameter at about 800°C. The apparent lattice strain was largely annealed at this temperature. The effects of higher burnup to 2.2×10^{20} f/cm^3 in UO_2 pellets irradiated at central temperatures up to 2300°C were examined by x-ray diffraction and microhardness measurements. The lattice parameter remained unchanged except for a decrease ($\Delta a/a$) of some 10^{-4} at central temperatures above 2000°C. At irradiation temperatures below 1300°C the microhardness increased by about 35% after irradiation to 5×10^{18}–1.5×10^{19} f/cm^3. Between 1300 and 1700°C the irradiation hardening decayed with increasing irradiation temperature. At a fission density of 2.2×10^{20} f/cm^3 a second stage of irradiation hardening together with local lattice strains seemed to appear. (auth)

10202 CREEP BEHAVIOUR OF UO_2 UNDER NEUTRON IRRADIATION. Brucklacher, D.; Dienst, W.; Thuemmler, F. (Kernforschungszentrum, Karlsruhe, Ger.). pp 100-8 of Ceramic Nuclear Fuels. /Kruger, Owen L. (ed.). Columbus, Ohio; American Ceramic Society, Inc. (1969).

From 71st Annual Meeting of the American Ceramic Society, Washington, D. C. See CONF-690512.

An evaluation of results concerning microstructure and density changes of clad porous UO_2 under neutron irradiation indicated that below 1200°C the creep rate of UO_2 is strongly increased by irradiation. Irradiation enhanced creep rates due to various possible basic mechanisms were estimated and compared with those of purely thermal creep. It has been assumed that in the temperature range considered creep rates are essentially determined by diffusional creep according to the Nabarro–Herring model. Quantitative results show that the above mentioned estimated creep rate values can be completely explained only by the fission fragment generated thermal spikes. Enhanced diffusion by increased point defect concentration can also be effective. There are good reasons to conclude, that under fast-reactor conditions, the creep rate of UO_2 fuel under a stress of 2 kg/mm^2 would be at least equal to the linear swelling rate caused by the solid and condensed gaseous fission products. If the clad is able to resist this stress in the fuel, all the fuel pores should be able to absorb the fuel swelling, unless they are stabilized by internal fission gas pressure in a completely closed form. (auth)

10203 TRANSPORT PROCESSES IN OXIDE NUCLEAR FUELS. Christensen, J. A. (Battelle-Northwest, Richland, Wash.). pp 109-25 of Ceramic Nuclear Fuels. /Kruger, Owen L. (ed.). Columbus, Ohio; American Ceramic Society, Inc. (1969).

From 71st Annual Meeting of the American Ceramic Society, Washington, D. C. See CONF-690512.

Studies of mass and energy transport in fuels directed toward coordinating precision laboratory measurements with in-pile experiments designed to yield specific materials property data are discussed. Results are applied to fuel systems design and behavioral model development. Emphasis has been on mixed uranium–plutonium oxides with lesser efforts on UO_2, mixed nitrides, and uranium oxycarbides. Thermal diffusivities for various fuel materials have been measured at temperatures to 1700°C. Results together with studies of associated thermodynamic properties, melting points, phase equilibria, electrical and thermoelectric properties, and materials synthesis methods, have been applied toward designing and interpreting a variety of irradiation experiments such as measurements of stoichiometry and fabrication method effects on in-pile heat transfer in $(U,Pu)O_{2+x}$ and UO_2; determination of stoichiometry and heat rating effects on oxygen, plutonium, and fission fragment distributions in oxide fuels; observations of relations between void and fission fragment distributions and fuel thermal history; characterization of irradiated mixed-oxide structures in terms of stoichiometry and heat rating; and studies of dimensional stability. (auth)

10204 EFFECT OF DENSITY AND STOICHIOMETRY ON OXIDE FUELS BEHAVIOR. Mikailoff, Hubert; van Craeynest, Jean Claude; Lallement, Robert (CEA, Fontenay-aux-Roses, France). pp 126-37 of Ceramic Nuclear Fuels. /Kruger, Owen L. (ed.). Columbus, Ohio; American Ceramic Society, Inc. (1969).

From 71st Annual Meeting of the American Ceramic Society, Washington, D. C. See CONF-690512.

Experiments are described on low density UO_2–PuO_2. In pile and out of pile measurements of the influence of density and stoichiometry on the properties of oxide fuels have been made. Effects of the density on microstructure, gas release, and in pile performance are presented. (auth)

10205 IRRADIATION TESTS OF SODIUM-BONDED MIXED CARBIDE FUEL PINS. Levine, P. J.; Harbourne, B. L.; Biancheria, A.; Boltax, A. (Westinghouse Electric Corp., Madison, Pa.). pp 156-65 of Ceramic Nuclear Fuels. /Kruger, Owen L. (ed.). Columbus, Ohio; American Ceramic Society, Inc. (1969).

From 71st Annual Meeting of the American Ceramic Society, Washington, D. C. See CONF-690512.

Sodium-bonded uranium–plutonium carbide fuel pins were irradiated in a thermal reactor to 50,000 MWd/te average burnup. $Cr_{23}C_6$-modified, Fe-modified, and unmodified hypostoichiometric fuels were included in the tests. Neutron radiographs were taken after an intermediate burnup level and after completion of the irradiation. Fuel volume changes were estimated from measurements of the neutron radiographs and compared with available data on carbide fuels. The $Cr_{23}C_6$-modified fuel swelled less than the Fe-modified and hypostoichiometric fuels. Considerable transverse and longitudinal cracking was noted in the pellets operated

at linear power ratings of 20 kw/ft and higher. The Fe-modified and hypostoichiometric fuels swelled sufficiently to contact the cladding. There was no indication of incompatibility between the fuel and cladding in any of the fuel pins. (auth)

10206 POTENTIAL OF MIXED NITRIDE (U,Pu)N AS A FAST REACTOR FUEL. Pardue, W. M.; Bauer, A. A.; Keller, D. L. (Battelle Memorial Inst., Columbus, Ohio). pp 166-78 of Ceramic Nuclear Fuels. /Kruger, Owen L. (ed.). Columbus, Ohio; American Ceramic Society, Inc. (1969).

From 71st Annual Meeting of the American Ceramic Society, Washington, D. C. See CONF-690512.

The features of mixed nitrides which made them attractive as fuels for LMFBR's are reviewed and evaluated. Included are both experimental data and literature review information. Such features as physical properties, irradiation resistance, fabrication techniques, compatibility, and nuclear characteristics are discussed, with possible performance-limiting features of the mixed nitrides being assessed. The mixed nitrides have good irradiation resistance and a potential for burnups in excess of 100,000 MWd/t with appropriate fuel-element design. Economic evaluations based on burnup potential, fabricability, and nuclear factors indicate that the mixed nitrides deserve serious consideration as the fuel for high-performance breeders. (auth)

10207 IRRADIATION TESTS OF FUEL RODS CONTAINING UO_2 AND $(U,Pu)O_2$ FOR GCFR. Long, E. L. Jr. (Oak Ridge National Lab., Tenn.); McQuilkin, F. R.; Cuneo, D. R.; Lindgren, J. R.; Siltanen, J. N. pp 179-84 of Ceramic Nuclear Fuels. /Kruger, Owen L. (ed.). Columbus, Ohio; American Ceramic Society, Inc. (1969).

From 71st Annual Meeting of the American Ceramic Society, Washington, D. C. See CONF-690512.

An irradiation test program is being conducted to develop fuel elements for the Gas-Cooled Fast Reactor (GCFR). Rods fueled with either UO_2 or $(U,Pu)O_2$ have been irradiated to burnups of 4,000 to 16,000 Mwd/tonne under the following conditions: linear heat ratings; 7 to 20 kw/ft surface temperatures; 650 to 835°C cladding; Hastelloy X or, in one instance, type 316 stainless steel. Additional tests operating under the same conditions are approaching 50,000 Mwd/tonne. No significant mechanical ratcheting of fuel pellets with cladding was observed. Reactions between fuel and cladding formed oxide layers and subsurface voids in the cladding. Two fuel rods collapsed and ruptured; therefore, alternate designs employing pressure equalization are being considered. (auth)

10208 IN-PILE MOBILITY OF FISSION GASES IN UO_2 FUEL RODS. Chenebault, P.; Delmas, R. (CEA, Grenoble, France). pp 185-94 of Ceramic Nuclear Fuels. /Kruger, Owen L. (ed.). Columbus, Ohio; American Ceramic Society, Inc. (1969).

From 71st Annual Meeting of the American Ceramic Society, Washington, D. C. See CONF-690512.

The stable isotopes of rare gases released by UO_2 have been collected during irradiation of cylindrical fuel rods at various specific powers. The concentrations of the same species have been determined in small cores drilled in the irradiated fuel. The release is slow, even though the temperature at the center of the rod is higher than 2000°C. The local concentration of a given stable fission gas is essentially not dependent on the irradiation temperature above 1700°C. Under steady power conditions, this concentration increases up to a limit that is the lower the higher the central temperature. The proportions of stable isotopes of xenon in the gases collected during irradiations do not correspond to the fission yields of the respective radioactive chains. Accordingly a departure from the expected concentrations is apparent near the center of the fuel under conditions where material transport by evaporation-condensation can occur. These observations can be explained by assuming that iodine and tellurium escape from hot UO_2. (auth)

10209 EFFECT OF TEMPERATURE AND BURNUP ON FISSION GAS RELEASE IN MIXED OXIDE FUEL. Baily, W. E.; Spalaris, C. N.; Sandusky, D. W.; Zebroski, E. L. (General Electric Co., Sunnyvale, Calif.). pp 195-210 of Ceramic Nuclear Fuels. /Kruger, Owen L. (ed.). Columbus, Ohio; American Ceramic Society, Inc. (1969).

From 71st Annual Meeting of the American Ceramic Society, Washington, D. C. See CONF-690512.

Evaluation of fission gas release data from $(Pu,U)O_2$ fuel irradiated to burnups from 50 to greater than 300,000 MWd/te under temperature conditions typical of LMFBR's indicate that two basic mechanisms control gas release. At low burnups a diffusion mechanism regulates gas release based on temperature level. Under these conditions a temperature-dependent diffusion model is applicable for fuel up to a temperature required to produce columnar grain growth. At higher temperatures, where a continuous pore migration phenomenon appears, the gas is released more quickly through a mechanism which involves coalescing and sweeping of fission gas to the center of the fuel. This picture is in general accord with previously published models. With increasing burnup fission gas release increases preceeded by a different process which is a direct function of burnup and to a lesser degree a function of temperature distribution and microstructural change. This effect is attributed to enhanced gas diffusion in both the low and high temperature regions of the fuel and is represented by an empirical model developed for fuel pins irradiated in EBR-II. (auth)

10210 ELECTRON PROBE MICROANALYSIS OF IRRADIATED OXIDE FUELS. Stalica, Norbert R.; Seils, Charles A. (Argonne National Lab., Ill.). pp 211-24 of Ceramic Nuclear Fuels. /Kruger, Owen L. (ed.). Columbus, Ohio; American Ceramic Society, Inc. (1969).

From 71st Annual Meeting of the American Ceramic Society, Washington, D. C. See CONF-690512.

Techniques have been developed for the analysis of complete cross sections of highly irradiated UO_2 and UO_2–PuO_2 fuel pins in a partially shielded electron probe microanalyzer. The distribution of uranium, plutonium and the fission products, molybdenum, ruthenium, technetium, rhodium, palladium, strontium, yttrium, zirconium, praseodymium, cesium, barium, lanthanum, cerium, neodymium, promethium, samarium, europium, and gadolinium have been determined for fuel pins irradiated under different conditions. The interaction of the fission products with impurities in the fuel as well as the cladding were investigated. (auth)

10211 STUDIES OF IRRADIATION EFFECTS IN CERAMIC FUELS AT HARWELL. Frost, B. R. T. (Atomic Energy Research Establishment, Harwell, Eng.). pp 225-43 of Ceramic Nuclear Fuels. /Kruger, Owen L. (ed.). Columbus, Ohio; American Ceramic Society, Inc. (1969).

From 71st Annual Meeting of the American Ceramic Society, Washington, D. C. See CONF-690512.

Ceramic fuel irradiation studies at Harwell are concerned with the elucidation of swelling and gas release mechanisms rather than with statistical testing of fuel elements, although an important objective is to relate these two fields. To build up a complete picture of fuel element behavior it is necessary to study in detail fission gas bubble behavior, solid fission product characteristics, and the distribution of the fuel components. Both experimental and theoretical approaches are used. To complete the picture it is necessary to know the temperature distribution in the fuel and to improve performance it is necessary to study fuel strength. Experimental studies on these topics have been in progress for some time. Finally the need for developing models of fuel element behavior, as a link between fundamental and statistical studies, is recognized and work has started. (auth)

Plastics and Other Materials

10212 A SYSTEMATIC APPROACH TO THE PREDICTION OF FUEL PIN LIFETIMES. Sayles, C. W.; Mahlmeister, J. E. (Atomics International, Canoga Park, Calif.). pp 244-52 of Ceramic Nuclear Fuels. /Kruger, Owen L. (ed.). Columbus, Ohio; American Ceramic Society, Inc. (1969).

From 71st Annual Meeting of the American Ceramic Society, Washington, D. C. See CONF-690512.

The success of LMFBR's will depend on the ability of the fuel to operate to high burnups. The burnup behavior is one of the major areas of uncertainty that can affect the overall plant availability. A method for determining the expected lifetime of the fuel pin as a function of the required reliability is described. Models which account for changes in the properties of the fuel during irradiation are used. The first step is to use the models to determine the needed physical properties. This calibration of the model is done by adjusting the coefficients of the property equations until the results given by the model agree with previous experiments. Knowing the coefficients and their uncertainties, a reliability margin analysis of the fuel pin burnup can be made. Such analysis will not only give the reliability of the fuel pin performance, but also indicate the major causes of uncertainty. (auth)

10213 (ALO-2832-42) THERMAL INSULATION STUDY. Progress Report of Research and Development, June–November 1969. Grunert, W. E. (Union Carbide Corp., [Indianapolis, Ind.] Linde Div.). Contract AT(29-2)-2832. 77p. Dep. CFSTI.

Current status of long-term performance stability tests on the 1800°F composite and nickel opacified quartz multi-layer systems is presented and discussed. Increases in apparent thermal conductivity of ~30% were noted for both the 1800°F composite (5000-

hours operation) and the nickel opacified quartz system (10,000-hours operation). A study of potential degradation modes for the composite materials in 1800°F service has been completed. The flat plate thermal conductivity test program is complete. Apparent thermal conductivity data are presented for two recently evaluated systems: Mo–ZrO_2 multi-foil at temperatures from 1000 to 2500°F, and the 1800°F composite multifoil over a temperature range 500 to 1800°F and a compressive load range of .03 to 15 psi. The penetration effects test program is complete. Effective thermal conductivity data are presented for an aluminum–aluminum opacified glass multi-foil insulation containing 0.1" diameter lead telluride penetrations. Agreement was relatively good between predicted and measured total system performance. (auth)

10214 (CERN-69-12) EFFECTS OF RADIATION ON MATERIALS AND COMPONENTS. Megarad Dosimetry. Van de Voorde, M. H. (European Organization for Nuclear Research, Geneva (Switzerland)). 21 May 1969. 25p. Dep. CFSTI (U. S. Sales Only).

General information is presented on methods of measuring large radiation doses. Units of dosimetry are reviewed along with sources of radiation for damage studies. A guide to Megarad dosimetry methods is included and dosimeters for use around accelerators are described. (J.R.D.)

10215 EFFECTS OF γ-RAY IRRADIATION ON SLIDING FRICTION AND WEAR OF POLYTETRAFLUOROETHYLENE BASE BEARING. Karasawa, Koreyoshi; Fukai, Sadasuke (Osaka City Univ.). Mem. Fac. Eng., Osaka City Univ.; No. 10, 1–9(Dec 1968).

Polytetrafluoroethylene (PTFE), as a bearing material, was filled with graphite of 5 wt % and was irradiated with gamma radiation. To observe the relation between friction coefficient or wear and irradiation dose, and also frictional behavior, the material was slid on a rotating mild steel disk. Applied load was 30 kg/cm² and sliding velocity was 0.04 to 8.55 cm/sec at room temperature. In the preliminary experiment, no significant difference in the measured values was observed between one specimen which was stopped for a time at specific intervals and the other specimens which were continuously slid up to desired sliding distances. When irradiated, for each sliding velocity, the friction coefficient was minimum in the vicinity of gamma radiation dose 10^7 rad. Regardless of the sliding velocity, the relation between the total wear and the dose was linear over the sliding distance of 100 meters. (NSA of Japan)

10216 EFFECTS OF PRIOR NEUTRON IRRADIATION ON STRESS BUILD-UP IN GLASS CAUSED BY ULTRA-VIOLET LIGHT. Ooka, K.; Kishii, T. (Tokyo Shibaura Electric Co., Kawasaki, Japan). J. Mater. Sci.; 4: 1039-44(Dec 1969).

Ultraviolet light caused compaction of borate and borosilicate glasses, building up stresses in the irradiated surface layers. Assumed mechanisms of the stress buildup are briefly reviewed; they are based on the double bond character of the network of the glasses and the compaction processes start with photoexcitation, charge transfer or photoionization of $\geq B-O$ or $\geq B-O^-$ structural units of the glasses. The effects of prior neutron irradiation on the kinetics of the stress buildup and thermal release of the stress are examined. Prior neutron irradiation gives distinct changes in the kinetics of the stress buildup even at very low doses such as 10^7 neutrons/cm², causing an additive stress which appears and saturates within the early stage of ultraviolet irradiation. The effects of prior neutron irradiation disappear by successive heating at temperatures lower than 300°C. The stress enhanced by prior neutron irradiation is also thermally released by heating in the same temperature range. The threshold wavelength for the stress in neutron irradiated glass is similar to that in glasses not neutron irradiated. The π-bond character of the glass network seems to make the kinetics of the stress buildup sensitive to neutron irradiation even at low doses. Prior neutron irradiation forms a region in the glass network in which the stress buildup by ultraviolet light is facilitated, while elsewhere the kinetics of the stress buildup remain unchanged. (auth) (UK)

10217 NEUTRON-ABSORBING MATERIAL AND METHOD OF MANUFACTURE. Blum, Paul; Lefrancois, Jacques; Vinarnick, Louis (to Commissariat a l'Energie Atomique). British Patent 1,177,586. 14 Jan 1970. Priority date 14 Jun 1967, France.

The material is a mixture of 32 to 40 wt % polyethylene, 17 to 20 wt % water, and 37 to 45 wt % of plaster of paris, and 1 wt % boron. The boron is incorporated dry in the plaster of paris and the procedure consists of adding this mixture to water and homogenizing, adding polyethylene granules, and compacting by ramming. (J.R.D.)

10218 FABRICATION OF POLYSTYRENE MOULDINGS FOR USE AS REDUCED DENSITY HYDROGENOUS MODERATOR. Rose, A. (Australian Atomic Energy Commission, Sutherland, New South Wales). Nucl. Instrum. Methods; 77: 167-9(1970).

Techniques for the manufacture of expanded polystyrene mouldings to simulate the coolant in rod-cluster type nuclear fuel elements are described. At a density of approximately 40 lb per cubic foot, the hydrogen concentration of the mouldings is such that the moderating power is approximately half that of room temperature light water. (auth)

PHYSICS (GENERAL)

Astrophysics and Cosmology

10219 (MPI-PAE/Astro-24) METHODS OF NONLINEAR MECHANICS IN WEAK TURBULENCE. Eisaesser, Klaus (Max-Planck-Institut fuer Physik und Astrophysik, Munich (West Germany)). Aug 1969. 21p. Dep. CFSTI (U. S. Sales Only).

The equations of weak turbulence are derived within the time-asymptotic formalism of Bogolyubov and Mitropolski (1961). This procedure is very clear and simple in this connection, compared to the many-time-scale formalism (Newell 1968, Benney and Newell 1968). For instance, one can do all the time asymptotics in Fourier space and obtain in each order solutions that are uniquely determined, regardless of the results in later orders. (auth)

10220 DAILY VARIATIONS OF THE FREQUENCY OF A VERY ACCURATE RADIO FREQUENCY. Sadeh, D. S.; Au, B. D. (Naval Research Lab., Washington, D. C.). Nature (London); 224: 1291-3(27 Dec 1969).

An experiment is described that was designed with a view to the better understanding of the anomalous behavior of Cs clocks. The behavior of two Cs clocks at fixed locations was compared, and possible influences of environmental and astronomical origin on the rate of the clocks are discussed. The emitting station was Cape Fear, N. Carolina, and the receiving station was at the Naval Observatory, Washington. The experiment ran for 6 months, 24 hr a day. The important feature of the observations was a drop in the rate of the received ticks compared with local ticks in the mornings and a recovery in the afternoons; decrease in the rate began at sunrise. Temperature changes did not appear to be the reason for these rate changes, nor did humidity changes, and the regularity of the frequency drop ruled out any correlation with weather conditions. Any ionospheric influence could also be ruled out. The cause of the drop in rate was not clear. Consideration was given as to whether the decrease was connected in any way with the mass of the Sun and the Moon. It is believed that a new phenomenon was being observed, without any obvious explanation. (UK)

Stars

Refer also to abstracts 10378 and 10518.

10221 PHOTOMETRIC AND SPECTROSCOPIC OBSERVATIONS OF GLOBULAR CLUSTERS IN THE ANDROMEDA NEBULA. van den Bergh, Sidney (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Astrophys. J.; 19: Suppl. Ser. No. 171, 145-74(Dec 1969).

The 200-inch telescope has been used to obtain classification spectra, radial velocities, and UBV photometry for the brightest clusters in M31. The principal results of this study are given. (auth)

10222 RATIO OF HORIZONTAL-BRANCH STARS TO RED GIANT STARS IN GLOBULAR CLUSTERS. Iben, I. (Massachusetts Inst. of Tech., Cambridge); Rood, R. T.; Strom, K. M.; Strom, S. E. Nature (London); 224: 1006-8(6 Dec 1969).

It is stated that, for any globular cluster, comparison of the observationally estimated ratio N_{HB}/N_{RG} with a theoretically estimated lifetime ratio t_{HB}/t_{RG} enables an estimate to be made of the initial He abundance characterizing cluster stars. [N_{HB} is the total number of stars along the red giant branch that are as bright or brighter than the horizontal branch at roughly the level of the RR Lyrae stars that lie directly above cluster turnoff.] The ratio of relevant lifetimes is a moderately strong function of He abundance that varies from ~0.4 when Y (helium abundance by mass) is ~0.1 to about 1 when Y is ~0.3. The importance of determining Y led to a literature search for star count data from which N_{HB}/N_{RG} could be estimated; the findings are discussed. It was found that this ratio was ~0.79 — 0.90; the value 0.79 corresponds to an estimated initial He abundance Y of about ~0.24 to 0.28, and the value 0.90 to Y ~ 0.27 to 0.31. Age estimates could also be obtained by comparing t_{HB}/t_{RG} with N_{HB}/N_{RG}. Such estimates are very sensitive to whether or not neutrino losses occur as predicted by the conserved vector current theory of weak interactions. It is emphasized that the estimates for N_{HB}/N_{RG} are based on only one of many possible criteria for assigning stars to the giant branch and to the horizontal branch. Attempts were made to eliminate double nuclear shell source stars from the counts, and in arriving at number estimates judgement was exercised in eliminating all stars in all evolutionary phases later than the core helium-burning phase. Attempts to obtain sufficient completeness and resolution in number counts to justify the construction of a luminosity function are briefly discussed. It is regarded as significant that the most reliable value for N_{HB}/N_{RG} for a moderately metal-deficient cluster was nearly the same as the most reliable value for an extremely metal-deficient cluster, implying that initial Y values may not differ by more than 0.02 to 0.03. It is concluded that the mean initial He abundance characterizing globular cluster stars is in excess of Y ~ 0.5. (UK)

10223 STELLAR X-RAY SOURCES. Biermann, L. (Max-Planck-Institut fuer Physik, und Astrophysik, Munich. Astrophysik, Munich). Proc. Roy. Soc. (London), Ser. A; 313: 357-66(11 Nov 1969).

Attempts are made to provide order of magnitude estimates of the fluxes of quanta to be expected, on the basis of the solar data for stars of similar spectral type and luminosity and of theoretical inferences concerning the coronae of stars of other spectral and luminosity classes. The limited transparency of interstellar space makes it necessary to discuss also the value of the interstellar density between clouds, which is at present rather uncertain and may be as low as 1 hydrogen atom per 10 cm^3, and also the influence of the interstellar helium, which on the basis of new measurements seems to be less important than was thought until recently. Finally, the observability of stellar flares is discussed briefly, because such events would contribute quanta of higher energy than that of the quanta ordinarily to be expected from stellar coronae. 36 references. (auth)

10224 ABUNDANCE DETERMINATIONS IN LATE-TYPE STARS FROM SCHMIDT CAMERA OBJECTIVE PRISM SPECTRA. Samson, W. B. (Royal Observatory, Edinburgh). Mon. Notic. Roy. Astron. Soc.; 145: 373(1969).

Parameters corresponding to Fe abundance, CH-band strength, and CN-band strength along with a parameter corresponding to effective temperature were measured on objective prism spectra for 62 stars of types F and G. (W.D.M.)

10225 A SEARCH FOR GLOBULES IN OB CLUSTERS AND ASSOCIATIONS. Sim, M. E. (Royal Observatory, Edinburgh). Mon. Notic. Roy. Astron. Soc.; 145: 375(1969).

A search was made for Bok's globules in the 66 OB clusters and associations which have been searched for dust-embedded stars (Reddish 1967). The number of globules found in the 48 systems north of −33° declination is as follows:

	Group 1	Group 2	Group 3
12 OB Associations	43	42	29
36 OB Clusters	18	20	18

(W.D.M.)

10226 RADIO EMISSION FROM FLARE STARS NEAR THE ORION NEBULA. Slee, O. B. (Commonwealth Scientific and Industrial Research Organization, Sydney); Higgins, C. S.; Roslund, C.; Lynga, G. Nature (London; 224: 1087-9(13 Dec 1969).

The classical flare stars near the Sun sometimes emit large amounts of nonthermal radio energy during bright optical flares, and the probable detection of radio emission from a number of flare stars near the Orion Nebula at a distance of ~400 pc is reported. Compared with flare stars in the solar neighborhood there was a dilution factor of $\sim 10^3$ in intensity on account of the greater distances, but it is thought this is largely compensated by the much greater amounts of energy released during flares on these stars. The radio emission cannot be derived from the incoherent cyclotron mechanism, but may be explained in terms of coherent plasma oscillations or amplified gyro or synchrotron emission. Simultaneous optical and radio observations of the Orion Nebula flare stars were conducted in Australia during Dec. 1963 and Nov. 1968, the optical observations being made with the 50/65/175 cm Schmidt telescope at Mount Stromlo and the radio observations with the 64-m reflector at Parkes. On good nights the optical system was able to record stars of apparent photographic magnitude 17, and the main body of the flare stars in the Orion aggregate should have been reached. The radio observations were made simultaneously at low frequencies (136 MHz in 1963, 150 MHz in 1968) and the other, 408 MHz. The probability that a particular flare would be covered at both frequencies was only ~0.1. Both receivers accepted linearly polarized waves. The radio charts were closely examined near the times of occurrence of optical flares, and the average flare rate was $\frac{1}{4}$ h^{-1}. The light and radio curves for two representative flare events are shown, together with curves during a very bright flare on Dec. 21, 1963. The radio curves show a smooth and rapid increase and a much more prolonged decay, very

similar to the shape of the light curve. Near the peak of the flare the ratio of flux densities at 136 and 408 MHz was consistent with a power law spectrum. The essential data from all flares recorded are shown. Six of the eight flare events seen appear to have been associated with detectable radio emission at 136 MHz. Three flares were monitored at 408 MHz and two of them were associated with significant radio deflections; one also coincided with emission at 136 MHz. Two basic kinds of radio bursts were observed—short impulsive deflections lasting between 1.5 and 5 min and having high peak flux densities; and smooth bursts of lower peak flux density with much longer durations. It appears unlikely that the large quantity of excess optical energy responsible for the intense optical continuum can originate in a thermal process. (UK)

10227 VULCANISM AND SEISMICITY IN NEUTRON STARS. Dyson, Freeman J. (Naval Research Lab., Washington, D. C.). Comments Astrophys. Space Phys.; 1: 198-206(Nov-Dec 1969).

The purpose of the present Comment is to discuss the consequences that follow, if one takes seriously the notion that a neutron star behaves more like the Earth (with its mantle) than like a normal star. The most conspicuous phenomena associated with The Earths' mantle are vulcanism and seismicity, and the questions considered are whether these phenomena have analogs in neutron stars, and if so, is there any way to decide observationally whether such phenomena actually occur. (W.D.M.)

10228 THE PLANETARY NEBULAE. IX. Aller, Lawrence H. (Univ. of California, Los Angeles). Sky Telesc.; 39: 15-18(Jan 1970).

Studies of the planetary nebulae in the far infrared and in the ultraviolet are reviewed, and spectroscopic changes are discussed. (W.D.M.)

10229 PHOTOMETRY OF NGC 4103. Wesselink, A. J. (Yale Univ., New Haven). Mon. Notic. Roy. Astron. Soc.; 146: 329-38(1969).

The southern galactic cluster NGC 4103 has been studied photometrically. For 512 stars brighter than V = 17m magnitudes and colors are given. Spectral types are derived for 17 of the brightest using U, B, V photometry. Spectroscopic observation of star 12 reveals MK B2IVe. Probably no stars having types earlier than B2 exist in the cluster. The mean color excess $E_{B-V} = 0.30$. The apparent distances modulus was found to be 12.0. With an absorption of 1.0 the true distance modulus and the distance are 11.0 and 1600 parsecs respectively. An age of 27×10^6 years from the turn off point on the main sequence was found. The eclipsing variable AI Crucis is the 5th brightest star of the cluster and almost certainly a member. Popper and Thackeray observed line doubling in the spectrum (B2IV + ...) of this star. (auth) (UK)

10230 SUPERNOVAE, NEUTRON STARS, AND PULSARS. Cameron, A. G. W. (Yeshiva Univ., New York. Goddard Space Flight Center, New York). Trans. N. Y. Acad. Sci.; 31: 769-86 (Nov 1969).

Topics covered in this review include properties of pulsars, theories of pulsars, supernova explosions, properties of neutron stars, pulsar emission mechanisms, and observability of pulsars. (W.D.M.)

10231 STRUCTURE AND EVOLUTION OF STARS OF VERY LOW MASS. Hoxie, Dwight Thomas. Tucson, Ariz.; Univ. of Arizona (1969). 196p.

Thesis.

Both an "idealized" and a "detailed" approach are employed to calculate the pre-main-sequence evolutionary behavior and main sequence structure of very low mass stars of nearly solar composition (X = 0.739, Y = 0.240, Z = 0.021). (TSS) (Diss. Abstr.)

10232 EVOLUTION OF INITIALLY PURE ^{12}C STARS AND THE PRODUCTION OF PLANETARY NEBULAE. Kutter, George Siegfried. Rochester, N. Y.; Univ. of Rochester (1969). 157p.

Thesis.

The evolution of stellar models composed initially of ^{12}C with masses between 1.04 and 1.55 $M_\odot$ was followed by detailed computations. These models are an approximation to the cores of evolved stars and, therefore, a study of their evolution may reveal a mechanism by which mass loss occurs from evolved stars, as in the production of planetary nebulae. The model computations are based on the Henyey method of integration. Temperature-dependent electron degeneracy, electron conduction, nuclear reactions, and energy loss by neutrino emission are included. The lower limit on the stellar mass for ^{12}C-ignition in initially pure ^{12}C stars is 1.08 $M_\odot$. ^{12}C stars of 1.08 $M_\odot$ ignite in an electron degenerate shell of fractional mass 0.7, while more massive stars ignite closer to the center. ^{12}C stars above 1.58 $M_\odot$ ignite centrally. This shell flash for $1.08 \leq M/M_\odot \leq 1.58$ lasts about 500 years. The net gain of energy during this interval is about $\frac{1}{3}$ of the total preflash energy ($E = U + \Omega$) of the stars, but there is no indication of mass loss. In stars below ~1.2 $M_\odot$ flash expansion quenches ^{12}C shell burning, whereas above ~1.2 $M_\odot$ the star expands until nuclear gains and neutrino losses balance. In the latter stars the shell burning advances to within less than 0.2 $M_\odot$ of the surface on a time scale of 25,000 years. Surface convection starts as the luminosity approaches 10^5 $L_\odot$. Near this value of the luminosity, the divergence of radiation pressure becomes greater than the opposing gravitational body force and, hence, the material appears to become unbound. This represents a possible mechanism for the production of planetary nebulae. The approximate agreement that exists between the theoretical results and the observational data on planetary nuclei and nebulae, such as the mass range, the rate of formation, the track in the $\log(L/L_\odot)$, $\log(T_{eff})$ diagram, and the composition of planetary nuclei, as well as the energy required for the expulsion of the nebulae support this connection. (Diss. Abstr.)

10233 FORMATION OF STARS WITH PARTICULAR APPLICATION TO TEMPORARY STARS AND QUASARS. Williams, I. P. (Univ. of Reading, Eng.). Mon. Notic. Roy. Astron. Soc.; 146: 339-50(1969).

It is assumed that all gas clouds have tendencies to fragment into unstable cloudlets. A number of conditions which these cloudlets must satisfy before they play an important part in the development of a contracting gas cloud are postulated. Formulae giving the average mass of the stars that form out of a contracting gas cloud in terms of various parameters are then derived. When numerical values lying within reasonable ranges are inserted, it is shown that a gas cloud of average stellar cluster mass, 10^{36} g to 10^{38} g, will form stars with a mass inside the usual stellar mass range. The formation could occur in either a spherical or a flattened stage. An initial cloud of mass 10^5 $M_\odot$ forms objects of mass slightly above the stellar range and these can, therefore, be classified as temporary stars. These are shown to explode at a rate of about 30 per year as is required in order to explain the quasar phenomenon, the linear dimensions of the whole group of temporary stars is of the order of a light year. (auth) (UK)

10234 NEW SOURCE OF INTENSE MAGNETIC FIELDS IN NEUTRON STARS. Canuto, V. (Goddard Space Flight Center, New York); Chiu, H. Y.; Chiuderi, C.; Lee, H. J. Nature (London); 225: 47-8(3 Jan 1970).

Reference is made to the problem of intense magnetic fields in gravitationally collapsed bodies. The radio emission from neutron stars (pulsars) suggests strong magnetic fields of the order of 10^{12} G. According to the law of flux conservation in a collapse process the magnetic-field strength increases as the square of the contracting factor α (>1). If the initial magnetic field is of the order of 10^3 G (the field in sunspots) before collapse, then assuming contraction from a star of one solar radius (~10^{11} cm) to that of a neutron star (10^6 cm) a field strength of 10^{13} G may be achieved. Magnetic fields in ordinary stars are usually attributed to non-equilibrium processes such as the existence of currents in the form of drifting charges, but it is shown that a new kind of quasi-equilibrium state exists, which possesses a uniform self-consistent magnetization. The case is considered of a degenerate electron gas of density ρ, in thermal equilibrium, where there are no currents in the form of drifting charges, that is, the local average velocity for electrons V_e and ions V_i is identically zero. Classically, such an electron gas possesses no net magnetic field, but it is shown in certain conditions a net magnetization can arise in an ideal degenerate electron gas at near-zero temperature; these conditions arise from the previous magnetic history of the electron gas, and the magnetization is due to the magnetic movement associated with Landau levels, that is, the energy states of charged particles in a magnetic field. The term LOFER (Landau Orbital Ferromagnetism) is suggested for this state of magnetization. This concept is further developed in the present communication. According to the theory, a state of quasi-permanent magnetization may persist even after the current giving rise to the original field has been dissipated, and because this magnetization is likely to be along a particular direction the magnetic field of a collapsed body is likely to be of the dipole type. The LOFER field in a white dwarf is 10^7 G and in a neutron star 10^{12} G. (UK)

10235 PASCHEN DISCONTINUITY IN B STARS. Ringuelet, Adela E. (Univ., Liege. Univ., La Plata). Astrophys. Space Sci.; 5: 459-68(Dec 1969).

Measurements of the Paschen discontinuity in stars with $T_{eff} \geq 10^4$ K leads to the conclusion that the D_P/D_B ratio increases with temperature faster than expected. The increase of D_P/D_B with $(\log g)^{-1}$ is also steep. (auth)

10236 FAR-ULTRAVIOLET PHOTOMETRY OF ORION STARS. Carruthers, George R. (Naval Research Lab., Washington, D. C.). Astrophys. Space Sci.; 5: 387-402(Dec 1969).

Far-ultraviolet photometric data for early type stars in Orion, in the 1050 to 1180 and 1230 to 1350 Å wavelength ranges, were obtained in an Aerobee rocket flight on January 30, 1969. The results corrected for interstellar extinction, appear in good agreement with model atmospheres in the case of main-sequence stars. Bright giant and supergiant stars, however, appear to be up to one magnitude fainter than main-sequence stars of similar spectral class in the 1050 to 1180 Å range. The present results indicate that the detectors used in a previous flight were lower in sensitivity than was thought, so the results from that flight have been corrected using the present data for stars in common with the previous flight. The far-ultraviolet extinction law for θ Orionis is shown to be abnormal, with the observed extinction far less than predicted on the basis of ultraviolet extinction measurements of other stars, and the observed E(B−V). (auth)

10237 THE SPECTRUM OF THE Bp STAR HD 36916. Hack, M. (Osservatorio Astronomico, Trieste, Italy). Astrophys. Space Sci.; 5: 403-19(Dec 1969).

The spectrum of the peculiar Bp star HD 36916 was studied on plates with dispersion 9.7 A/mm and compared with those of η Aur, B3V, and ι And, B8V. A comparison of the observed contours of Hβ, Hγ, and of the Balmer discontinuity D with those computed by Mihalas gives the following results: HD 36916: θ_e = 0.347, logg = 3.8; ι And: θ_e = 0.383, logg = 3.2; η Aur: θ_e = 0.302, logg = 3.6. HD 36916 presents the characteristics of the Si-λ4200 stars: strong deficiency in helium and probably also in oxygen and nitrogen, strong excess of silicon and strontium; 3984 HgII is present. Moreover, this star also has characteristics which are not common to Si-λ4200 stars but rather to Mn stars: excess by a factor of ten of the elements of the iron group and an excess larger, probably of the order of 100, for manganese. The star is a member of the Sword subgroup of the Orion association. (auth)

10238 OPTICAL AND RADIO STUDY OF BL LACERTAE. Bertaud, Ch. (Observatoire de Paris-Meudon, France); Dumortier, B.; Veron, P.; Wlerick, G.; Adam, G.; Bigay, Ja.; Garnier, R.; Duruy, M. Astron. Astrophys.; 3: 436-42(Dec 1969). (In French).

Frequent measurements of the flux of the variable object BL Lac were made. The optical observations consist of two series: one series of photographs taken with Schmidt telescopes and one series of visual measurements. These observations make use of a photoelectric sequence of 8 stars, very close to BL Lac. During the second half of 1968, the brightness varied in an interval of 2 magnitudes and sometimes quick changes were observed: for example 0.7 mag in 74 minutes, 1.3 mag in 20 hours. The interstellar absorption, in the direction of BL Lac was estimated, by using the reddening of the photoelectric sequence stars. With the adopted value, A_v = 1.2, the position of BL Lac in the (U−B, B−V) diagram is at the limit of the domain occupied by the quasars, near the variable object 3C 196. Also the slope of the continuous spectrum, measured by Visvanathan or by Oke, Neugebauer and Becklin, is, after correction of the absorption, not significantly different of that of a quasar. The observations at the frequency 2695 MHz show an important activity. (auth)

10239 ON THE INTERPRETATION OF S DORADUS. Martini, A. (Laboratorio di Astrofisica, Frascati, Italy). Astron. Astrophys.; 3: 443-51(Dec 1969).

Three slit spectra of S Dor during the spectroscopic minimum revealed in the years 1945−46 are compared with two taken at maximum phase in the years 1952 and 1957, respectively. At the minimum phase (which is well marked in 1946, February 2) 14 [Fe II] emission lines are recorded between 3900 and 5000 Å, compared with 7 observed by Wesselink in the minimum of 1955 and 20 observed by Thackeray in the minimum of 1964. [S II] is also represented by the line at 4068 Å. Mg II 4481 appears to be weakly present in absorption while He I (which Wesselink and Thackeray found relatively strong) is absent. Fe II is represented by 14 emission lines; very few of these lines show a P Cyg structure: on February 2, 1946, only Fe II 4583 shows a companion absorption line. Ti II is absent both in emission and in absorption. The spectral type suggested is B8eq. At the maximum phase, the P Cyg features are very well developed in the lines of H, Fe II, Ti II, Ca II. The Ti II−Fe II anomaly is well marked in 1952 but not in 1957. The spectral types suggested are A5eq in 1952 and A3eq in 1957. All the lines observed in the range 4861 to 3691 Å were identified, and a visual estimate of their intensity at the various phases is given. The radial velocity was measured for all the unblended lines. The emission lines show a shift appreciably constant at the various phases while the absorption lines are more shortward displaced at maximum than at minimum. By combining the photometric and spectroscopic observations, the general behavior of S Dor is examined and possible explanations are discussed. It seems that an ejected-shell mechanism is not inconsistent either with the observational evidences or theoretical requirements. From the evolutionary point of view, the possibility that S Dor is a contracting pre-main-sequence star is considered. (auth)

10240 A THEORETICAL INVESTIGATION OF FOCAL STELLAR IMAGES IN THE PHOTOGRAPHIC EMULSION AND APPLICATION TO PHOTOGRAPHIC PHOTOMETRY. Moffat, A. F. J. (Ruhr-Univ., Bochum, Ger.). Astron. Astrophys.; 3: 455-61(Dec 1969).

Two-dimensional intensity profiles of focal stellar images in photographic emulsions were derived by convolving gaussian seeing distributions with diffraction profiles and emulsion scattering functions. The results predict too low an intensity for large radial distances from the center of the image, contradicting the assumption that seeing is gaussian. An analytic formula representing observed image profiles combined with an expression for the characteristic curve led to calibration curves for iris photometers. The curves which were based on five physical parameters were tested using photoelectric standards and found to be valid over at least six magnitudes including the plate limit. These parameters can be determined from bright standard stars making it possible to obtain magnitudes of faint stars for which there are no photoelectric standards. In the case of variable background intensity the theory predicts too small an iris diameter for bright stars embedded in bright background. This is due to neglect of the depth of the emulsion. (auth)

10241 THE LIGHT CURVE OF 1 CARINAE. Feinstein, A.; Muzzio, J. C. (Univ. Nacional, La Plata). Astron. Astrophys.; 3: 388-401(Dec 1969).

From 178 photoelectric observations distributed over a 17 year interval, a period of 35.5330 ± 0.00084 d was derived for the brightest cepheid 1 Carinae. The residuals of these observations calculated from the best fitting Fourier series show periodicities of 190.1 and 29.92 days, both with an amplitude of the order of 0.02 m in V. There is another doubtful periodicity of 16.92 days. The principal period shows no continuous change in time larger than 0.001 day/year. Except for the secondary periods the curve seems to repeat itself closely over the whole time interval considered. (auth)

10242 BROADENING OF HYDROGEN LINES IN A NEUTRAL MEDIUM. Lortet, M. C.; Roueff, E. (Institut d'Astrophysique, Paris, Observatoire, Meudon, France). Astron. Astrophys.; 3: 462-7(Dec 1969).

The effects of dispersion van der Waals interaction between hydrogen atoms are taken into account for hydrogen lines, in addition to the resonance interaction first introduced by Cayrel et al., (1960) in a neutral medium. Although the widths relative to each interaction are not simply additive (Lewis, 1967, and Fig. 2) the van der Waals interaction is seen to give a contribution for the Balmer lines and even to be preponderant for Hδ. The validity of the 1/r expansion for the interatomic potential for Hγ and Hδ lines is questioned, since the range of the interaction is less than the dimensions of the atom in its correspondent state. (auth)

10243 COMMENT ON A PAPER OF S. KATO AND Y. NAKAGAWA ON GENERATION OF MAGNETIC FIELDS IN ROTATING STARS. Stix, M. (Max-Planck-Institut fuer Physik and Astrophysik, Munich). Astron. Astrophys.; 4: 161-2(Jan 1970).

It is pointed out that the effect of momentum transfer between photons and electrons on the generation of a toroidal magnetic field in a rotating star should be taken into account. (auth)

10244 THERMAL CONDUCTIVITY IN STELLAR ATMOSPHERES. I. WITHOUT MAGNETIC FIELD. Ulmschneider, P. (Univ., Wuerzburg, Ger.). Astron. Astrophys.; 4: 144-51(Jan 1970).

The coefficient of thermal conductivity for pure hydrogen, pure helium, and a gas mixture appropriate for a stellar atmosphere was computed in the temperature range 3,000 to 100,000°K and the range of gas pressure from 10^{-3} to 10^{6} dyn/cm^2. The translational as well as reactive contributions to the coefficient are given. The error is less than 10% (except for pure He) in the neutral region but may be more than 35% in the ionizing region. In the fully ionized region there is complete agreement with Spitzer and Härm (1953). (auth)

10245 ANOMALOUS EXCITATION ON 57 CYGNI. Napier, W. McD.; Ovenden, M. W. (Royal Observatory, Edinburgh. Univ. of British Columbia, Vancouver). Astron. Astrophys.; 4: 129-33 (Jan 1970).

An attempt is made to interpret the observations of the binary 57 Cygni in terms of the thermal reflection effect. It is found that the components cannot heat each other to the degree apparently required by the presence of ions appropriate to an O-type

star in the B3 spectrum. A correlation between the velocity amplitudes of individual absorption lines and their wavelengths is also shown to be inexplicable in terms of a conventional reflection effect. It is tentatively suggested that the high-temperature lines are formed in a chromosphere. The latter might arise from the dissipation of turbulence over the heated hemispheres: turbulent motions are shown to be expected as a consequence of the mutual heating of the stars. (auth)

10246 THE MULTIPLE SYSTEM OF ALGOL. Frieboes-Conde, H.; Herczeg, T.; Hoeg, E. (Hamburger Sternwarte, Hamburg). Astron. Astrophys.; 4: 78-88(Jan 1970).

An investigation was carried out at the Hamburg Observatory to clarify the structure of the multiple system Algol (β Persei), with special respect to possible unseen components. The extended series of astrometric observations by van de Kamp et al. is rediscussed by using improved spectroscopic elements (Ebbighausen) for the triple system, Algol AB-C. Little change was found in the 1.862a triple star orbit but a combined solution for this motion and a hypothetical 32-year periodicity revealed that the latter does not correspond to an orbital motion. An analogous, negative result was achieved for the so-called great inequality in the observed times of minima. Considering the available meridian observations, especially those made since the 1880s, any possibility of a corresponding orbital motion can be ruled out, with the motion of the triple system remaining virtually rectilinear. After excluding two hypothetical unseen components and the possible light time effects caused by them, a new description is put forward of the observed O − C diagram for the times of minima. A good representation of all photoelectrically determined epochs can be achieved by accepting two abrupt changes of the eclipsing period (occurred in about 1944, $\Delta P = +3.5$ s and in 1952, $\Delta P = -2.1$ s). Superposed on these sudden changes are the 32-year periodic variation (Hellerich's elements) and the 1.862a light time effect. An attempt was also made to derive the luminosity of Algol C from astrometric data by comparing the measurements made during eclipse with the rest of the observations. The brightness difference between AB and C amounts to 2.1 + 0.6/−0.3 mag. (auth)

10247 THE DERIVATION OF ABSOLUTE MAGNITUDES FROM PROPER MOTIONS AND RADIAL VELOCITIES AND THE CALIBRATION OF THE H. R. DIAGRAM. II. Jung, J. (Observatoire, Paris). Astron. Astrophys.; 4: 53-69(Jan 1970).

A method of deriving statistical parallaxes based on the principle of maximum likelihood is discussed. Checks made with the aid of trigonometric parallax stars and by means of numerical experiments show this method to be more reliable than the usual methods. Its application to stars in the Bright Stars Catalogue results in a new calibration of the H−R diagram, based on proper motions and radial velocities only. From these data are derived an estimation of both the mean absolute magnitude and the dispersion of the absolute magnitudes for each spectral type. The luminosity of early-type stars derived from cluster parallaxes and distance moduli of associations is confirmed, but late-type giants appear to be brighter than it is generally assumed. (auth)

10248 LIGHT CURVE AND PHOTOMETRIC ELEMENTS OF AR AURIGAE. Johansen, K. T. (Copenhagen Univ. Observatory, Brorfelde, Denmark). Astron. Astrophys.; 4: 1-10(Jan 1970).

Photoelectric observations of the eclipsing binary AR Aur were carried out in four spectral regions at approximately the same wavelengths as the Strömgren u, v, b, y system and in two regions around Hβ. The peak wavelengths close to u, v, b, y are all located in the continuum of the spectrum where limb darkening coefficients are available from the literature, and in these cases the photometric elements were determined. From the u, v, b, y, and Hβ observations, spectral types and absolute magnitudes were determined for the components. (auth)

Quasi-Stellar, Radio, and X-Ray Sources

10249 VARIATIONS OF SMALL QUASAR COMPONENTS AT 2,300 MHz. Gubbay, J. (Univ. of Adelaide); Legg, A. J.; Robertson, D. S.; Moffet, A. T.; Ekers, R. D.; Seedel, B. Nature (London); 224: 1094-5(13 Dec 1969).

Reference is made to a communication by the authors (Nature 222: 730(1969) in which long-baseline interferometer measurements were reported of several quasar radio sources using stations of the NASA/JPL Deep Space Network in Australia and California. Comparison of three sets of similar observations shows evidence for secular variations in the apparent intensities of small-diameter components in several of these objects. The results are compatible with the theory of expanding synchrotron sources, but an apparent expansion velocity greater than light appears to be required for a recent outburst in 3C 273. The observing frequency was 2,298 MHz or $\lambda = 13.1$ cm. Observations made in June 1969 confirmed the fringe amplitude changes in several sources reported earlier in Nov. 1967. The history of such changes in the three sources 3C 273, 3C 2791, and P 1510-08 are discussed, measurements being made at DSS 51. It is evident that the fringe amplitudes of 3C 279 and P 1510-08 have increased, while that of 3C 273 has remained nearly constant; the flux density of 3C 279 increased, while that of 3C 273 and P 1510-08 decreased. The interpretation seems clearest in the case of 3C 279. It has been proposed that this object has four components, three of size $\gtrsim 0.002$ arc s and one of smaller size. This further component must be that which contributes almost all of the observed fringe intensity at 8×10 wavelengths spacing. In the case of 3C 273 the change in total intensity is not reflected in the fringe amplitude; the decrease in its 13-cm flux density probably means that this expanding component is now optically thin at this wavelength and its angular size even in Nov. 1967 was >0.002 arc s. This would be the third of the four components to which reference has already been made. If it is supposed that 3C 273 is at the cosmological distance indicated by its redshift, then the radius of this component in Nov. 1967 must have been at least three times the velocity of light. Rees (1967) showed that apparent expansion velocities >c are consequences of relativistic expansion, leading to a conclusion of a Lorentz factor $\gamma \geq 3$. This is the first direct evidence that expansion in variable sources may occur at relativistic velocities. For P 1510-08, no simple interpretation was possible. (UK)

10250 GROUND BASED OBSERVATIONS OF X-RAY SOURCES: A SHORT REVIEW. Gratton, L. (Laboratorio di Astrofisica, Frascati, Italy. Dudley Observatory, Albany, N. Y.). Proc. Roy. Soc. (London), Ser. A; 313: 317-30(11 Nov 1969).

Forty-five x-ray sources were announced up to October 1968; five (possibly seven) of these have been identified convincingly with optical objects; seven more have very well determined positions and it may be hoped that they will be identified in the near future; of the remaining objects, eight have been observed in several flights and their existence is beyond doubt, although their location is poorly known; 23 have been observed only in one flight and for some of them it is still uncertain whether they are real or not. The identified sources belong to three categories: (A) supernova remnants; (B) sources whose optical counterparts are starlike objects having spectra resembling old novae; (C) radiogalaxies (only Vir A = M87 belongs to this class). After a short critical discussion concerning the distribution of x-ray sources in the sky and a comparison with the distribution of other known objects, a short review is given of optical observations of objects of class B. 65 references. (auth) (UK)

10251 DISCRETE X-RAY SOURCES: A THEORETICAL APPRAISAL. Burbidge, G. (Univ. of California, San Diego). Proc. Roy. Soc. (London), Ser. A; 313: 331-48(11 Nov 1969).

Attempts are made to unravel the theoretical questions that have been raised by the discovery of discrete x-ray sources. The discussion is divided into three sections: (1) galactic sources, (2) extragalactic sources; and (3) possible discrete sources of γ-rays. 67 references. (auth) (UK)

10252 QUASI-STELLAR RADIO SOURCES. Lequeux, J. (Observatoire de Paris, Meudon, France). pp 111-21 of Colloque National de Physique Theorique. Exposes Generaux sur des Sujets d'Actualite, Marseille, 19−22 Avril 1967. Paris; Centre National de la Recherche Scientifique (1969). (In French).

From National Conference on Theoretical Physics, Marseille, France. See CONF-670459.

A review of quasi-stellar radio sources is presented. The discussion covers a brief historical review, optical properties, radioelectric properties, a model of a quasar, the distances of quasars, relations between galaxies and quasars (their statistical properties), and the nature of quasi-stellar objects. 45 references. (J.F.P.)

10253 ANOMALOUS TEMPORAL BEHAVIOUR OF NP 0532. Ramaty, R.; Holt, S. S. (Goddard Space Flight Center, Greenbelt, Md.). Nature (London); 224: 1003-4(6 Dec 1969).

It is stated that recent high-precision studies of the temporal behavior of NP 0532 in the radio and optical bands have yielded conflicting values for the second derivative of its period, leading to difficulty regarding the physical processes with which this behavior can be reconciled. It is pointed out that a comparison of these results with each other, and with other NP 0532 data, indicates that the average second derivative over periods of time longer than a few months is inconsistent with that measured in the high-precision measurements. This might be due to discontinuous decreases in the period, due to the sudden speeding-up of

the rotating neutron star. It is concluded that measured values of the second derivative may not necessarily give a reliable indication of the braking mechanism. A magnetic dipole braking mechanism in NP 0532 is favored as being consistent with all the data when discontinuous period variations are included to account for anomalous changes of the second derivative. (UK)

10254 LINEAR INCREASE IN PERIODICITY OF THIRTEEN PULSARS. Hunt, G. C. (Univ. of Manchester, Jodrell Bank, Eng.). Nature (London); 224: 1005-6(6 Dec 1969).

It is stated that continuing observations of the times of arrival of radio pulses from the pulsars visible from Jodrell Bank indicate that almost all periodicities are increasing at a uniform rate. No second effects of the kind observed for NP 0532 have, however, been discerned, and none of the 13 pulsars analyzed show any anomalous behavior similar to that of PSR 0833. Errors due to the motion of the observatory round the barycentre of the solar system are discussed, together with corrections. It is found that NP 0525, PSR 1642, and AP 0823 are apparently slowing uniformly, but owing to the short duration of the observations it is not yet possible to distinguish a real effect from an apparent effect caused by positional uncertainty. Results for the rate of change of period for the 13 pulsars are shown tabulated. It appears that CP 0808 cannot be increasing in period faster than 1 part in 1.5×10^{16}/sec. If the regularity of radiation pulses from pulsars is due to their being neutron stars rotating once per period, then an increasing period can be explained by the loss of angular momentum due to magnetic torque applied through the external magnetic field. It has been suggested that the emission from a pulsar derives its energy from the loss of rotational energy of the star, but results for CP 0808, regarded as a typical pulsar, suggest that there must be another source from which the radiation derives its energy. This could be either the magnetic field energy or gravitational energy. (UK)

10255 RAPID VARIATIONS IN THE RADIO POLARISATION OF BL LAC. Olsen, E. T. (Univ. of Michigan, Ann Arbor). Nature (London); 224: 1008-9(6 Dec 1969).

The nonthermal radio source VRO 42.22.01 (BL Lac) shows linear polarization in both the radio and optical regions of its spectrum, and it has been found that variations in its total flux density are the most rapid so far detected. The results of monitoring this source since April 1968 at 8 GHz (3.75 cm) are presented and discussed; large variations in its linearly polarized emission have been detected. Data for the position angle of the linearly polarized component, the linearly polarized flux density, and the total flux density as a function of the data of observation are shown graphically. The experimental apparatus and its calibration are described. There is excellent agreement between the data and those reported at 4.5 cm; but it is clear that after each of three major outbursts the flux density did not return to its former value. A slowly varying component was evident from Aug. 1968 to July 1969, the "quiescent" flux density rising by 1 flux unit every 150 days, apparently due to rapid minor outbursts. It is stated to be very difficult to analyze the data in terms of simple expanding source models, and it appears that continuous injection of relativistic electrons into the emitting region occurred; this injection was in spurts, some of which were major but the majority of which were small. The polarized flux density varied from 0.1 to 0.5 flux units over the period of observation, and the position angle of the polarized flux varied by nearly 80°, movements of 30° having been detected during the course of a week. It is concluded that the magnitude and rapidity of variations in the optical, radio, and polarized flux, as well as the peculiar radio spectrum, suggest that this source is a relatively young object. There is a good possibility that correlations between the optical and radio outbursts may be detected. (UK)

10256 MAGNETIC SUSCEPTIBILITY OF NEUTRON MATTER. Clark, John W. (Washington Univ., St. Louis). Phys. Rev. Lett.; 23: 1463-6(22 Dec 1969).

The magnetic susceptibility of a neutron gas at zero temperature, an idealization of neutron-star matter, is estimated for the realistic, soft-core nucleon–nucleon potential of Reid. For mass densities below twice that of ordinary nuclear matter, there is no sign of a ferromagnetically favorable instability of the normal ground state of the system, the effect of the interactions being to depress the magnetic susceptibility relative to its Fermi-gas value. (auth)

10257 INTERPLANETARY SCINTILLATIONS. V. A SURVEY OF THE NORTHERN ECLIPTIC. Harris, Daniel E.; Hardebeck, Ellen Gundermann (Cornell-Sydney Univ., Arecibo, Puerto Rico). Astrophys. J.; 19: Suppl. Ser. No. 171, 115-44(Nov 1969).

Source structure on the scale 0.1″ to 0.5″ was examined at the Arecibo Ionospheric Observatory by interplanetary-scintillation observations of 500 Parkes and 4C sources. These sources were observed only when the angular distance to the Sun was between 10° and 20°. This assured the presence of detectable scintillations at 430 MHz for this scale. Slightly over half of all the sources displayed scintillations. For most of these, rough values for the fraction of the source scintillating (μ) and upper limits to the diameter of the small component (ψ) were found. The results corroborate earlier deductions that most scintillating sources are complex, with at least one component being very small and containing a significant fraction of the total intensity. Because a large number of sources were examined, the occurrence of scintillations can be correlated with source intensity, source identification, and source spectra. The results indicate that: 1. There is no evidence for a statistical distance effect; that is, the scintillation index is not correlated with source intensity. However, the optically faint galaxies do scintillate more than the bright galaxies. 2. Three-quarters of the QSOs and one-half of the galaxies showed scintillation. 3. Most of the QSOs for which little or no scintillation was observed have normal or steep spectra. The strongly scintillating QSOs are more likely to have flat or curved spectra. (auth)

10258 INTERSTELLAR MASERS. Dickinson, Dale F. (Smithsonian Astrophysical Observatory, Cambridge, Mass. Harvard Coll. Observatory, Cambridge, Mass.); Litvak, Marvin M.; Zuckerman, Benjamin M. Sky Telesc.; 39: 4-7(Jan 1970).

In a survey of the possible mechanisms by which enormous enhancement of OH emission can occur, it was found that ultraviolet pumping, near-infrared pumping, and far-infrared pumping all can serve, and possibly also, collisions with atomic hydrogen. No one mechanism is apt to explain fully a given emission region, but one can often surmise which type of excitation is dominant. (W.D.M.)

10259 LONG-BASELINE INTERFEROMETER OBSERVATIONS AT 408 AND 448 MHz. I. THE OBSERVATIONS. Broten, N. W. (National Research Council, Ottawa); Clarke, R. W.; Legg, T. H.; Locke, J. L.; Galt, J. A.; Yen, J. L.; Chisholm, R. M. Mon. Notic. Roy. Astron. Soc.; 146: 313-27(1969).

Ten series of long-baseline interferometer observations were made at 408 and 448 MHz. The measurements were made between pairs of stations selected from four observatories in Canada and one in England. The longest baseline used was 6833 km. Measured fringe visibilities are given for 33 radio sources. Details are also given of observations of a further 28 sources for which no fringes were detected. (auth) (UK)

10260 EXTENSION OF THE RADIO SOURCE LUMINOSITY FUNCTION. I. OBSERVATIONS. Windram, M. D.; Kenderdine, S. (Mullard Radio Astronomy Observatory, Cambridge, Eng.). Mon. Notic. Roy. Astron. Soc.; 146: 265-312(1969).

The Cambridge one-mile radio telescope was used to make observations at 408 MHz of 478 weak sources in 110 areas centered on 3C and other sources. For most areas the limiting flux density is $\sim 0.2 \times 10^{-26}$ W m^{-2} Hz^{-1}; in one area it is as low as 0.066×10^{-26} W m^{-2} Hz^{-1}. The positional accuracy is about 10″ arc for most sources, enabling optical identifications to be made with objects as faint as 19.5 m. Statistical analyses show that the weak sources are not related to the neighboring 3C sources and hence a valid basis for determining the radio source luminosity function. (auth) (UK)

10261 DISTRIBUTION OF PULSAR DUTY CYCLES. Henry, G. R.; Pair, H. J. (Stanford Univ., Calif.). Nature (London); 224: 1188-9(20 Dec 1969).

A pulsar duty cycle is defined as the ratio of pulse width to period of pulse repetition, and on the basis of some simple physical assumptions a histogram is computed for the distribution of the duty cycles of 35 pulsars; the distribution fits observations reasonably well. It is assumed that a pulsar may be in the form of a "light-house beacon" with a conical beam of apex half-cycle ϵ; it is also assumed that ϵ is the same for all pulsars. The case where the center of the beacon lies in the equatorial plane of the pulsar is first discussed; such a pulsar would be observed from the Earth only if the latter lies within the angle ϵ from the pulsar equatorial plane. The beacon may not be in the equatorial plane, and the case where the beacons are randomly oriented is examined. Estimations are made of the fraction of all pulsars that it could be hoped to detect (out of those close enough to be detectable). It is found that if M pulsars are observed in a carefully surveyed region, then the total number of pulsars in that region would be expected to be 11M. The resulting histograms are discussed, and it is concluded that the over-simplified pulsar model adopted gives a reasonable first approximation to the distribution of pulsar duty cycles. (UK)

10262 PULSARS AND LOCAL COSMIC-RAY PREHISTORY. Lingenfelter, R. E. (Univ. of California, Los Angeles). Nature (London); 224: 1182-6(20 Dec 1969).

Pulsars have ages and distances which, if they are supernova remnants, would make them significant sources of local cosmic rays during the last 10^6 years. (auth) (UK)

10263 BOUNCING-CORE THEORY OF PULSARS. Harrison, E. R. (Univ. of Massachusetts, Amherst). Nature (London); 225: 44-6(3 Jan 1970).

It is argued that the catastrophic collapse of a star probably results in a "bouncing-core" configuration rather than a neutron star, and that "bouncing cores" explain many of the properties of pulsars in a more natural way than rotating neutron stars. The salient features of the bouncing-core theory of pulsars are stated to be: (1) The mechanism regulating the period is gravitational collapse and expansion. The observed period is increased by redshift, and unlike vibrating white dwarfs (or neutron stars) the central region has no equilibrium configuration. (2) The pulse originates as a burst of radiation from shells adjacent to the core during expansion, and its observed width is contracted because of the predominating Doppler effect. Pulsed emission is an essential characteristic of bouncing-core configurations, unlike rotating neutron stars which require an additional assumption such as surface irregularity or an oblique magnetic field to explain the pulsed emission. (3) The energy is gravitational in origin; loss of energy does not damp the oscillation in the ordinary sense, but causes the ceiling radius of the core to shrink towards the Schwarzschild radius, and hence increases the period. Only in the case of the existence of thinly clad cores has the pulse width a predictable relation with period; otherwise it is broadened and augmented with radiation from the envelope and has only a rough relation to period. (4) Most supernovae are possibly poorly clad bouncing cores and are therefore short-lived pulsars rapidly releasing energy. Such pulsars are possibly the source of most high-energy cosmic rays. If this theory is correct, pulsars provide a way of checking the general theory of relativity and of investigating the properties of matter at supernuclear density. The theory predicts that pulsars emit short and intense bursts of very high-energy neutrinos which may be detectable. If the core is rotating or has a quadrupole movement, it should also emit sharply pulsed gravitational waves. (UK)

10264 THE RADIO SPECTRA OF 3C SOURCES. Van der Laan, H. (Sterrewacht, Leiden). Astron. Astrophys.; 3: 477-80(Dec 1969).

The major features of a large sample of radio spectra are discussed. Particular reference is made to a recent joint NRAO–Cambridge publication of 3C source flux densities. The following conclusions are reached: (A) the many source spectra that are straight and smooth (in the log S_ν – log ν plane) are neither remarkable nor very informative; (B) many convex spectra would be straight but for the partial absorption of radiation at frequencies less than ~1 GHz. The fact that for convex spectra the median value of the spectral index $\alpha(750, 5000)$ is greater than for straight spectra is due to a selection effect operative when self-absorption is the cause of convexity; (C) although concave spectra are very rare, spectral data are consistent with the independence of component spectra in multiple sources; and (D) the absence of very steep spectra among 3C sources is the data's most remarkable feature. It has important implications for radio galaxy evolution. (auth)

10265 SECONDARY ELECTRONS IN RADIO SOURCES. Perola, G. C. (Sterrewacht, Leiden). Astron. Astrophys.; 3: 481-4(Dec 1969).

In a recent paper on the spectral evolution of radio galaxies, van der Laan and Perola (1969) show that models in which the relativistic electrons are supplied only for a period short compared to the source's lifetime contradict the available data. One way to produce relativistic electrons for an extended period is by means of collisions between the relativistic protons (which may be produced in a very brief interval of time) and the ambient gas. This note presents a detailed analysis of the physical conditions required to explain the observations through electrons of secondary origin. The theory is able to predict the near absence of exponentially steep spectra and the presence of many convex spectra in a complete sample. However, this theory requires very dense haloes (10^{-1} atoms per cc) surrounding the galaxies; these would produce observable effects, which are not detected. (auth)

10266 HIGH RESOLUTION MEASUREMENTS OF 21-cm ABSORPTION IN THE DIRECTION OF W 49. Kazes, I.; Nguyen-Quang-Rieu (Observatoire, Meudon, France). Astron. Astrophys.; 4: 111-14(Jan 1970).

New measurements of the hydrogen line absorption of the double radiosource W 49 were made with the Nançay radiotelescope. They reveal two H I clouds, one with radial velocity of 12 km/s already pointed out by different authors, and a second one, at about 63 km/s, both responsible for an enhanced absorption in the direction of the thermal component. The detection of the second cloud supports the nonphysically related double source hypothesis. (auth)

Solar Phenomena

10267 (CEA-BIB-156) SOLAR NEUTRINOS. Cavard, Andre (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Nov 1969. 46p. (In French). Dep. CFSTI (U. S. Sales Only).

Solar neutrinos are emitted when the thermonuclear fusion of hydrogen to helium occurs inside the central region of the Sun. Two mechanisms have been suggested for this reaction: the carbon–nitrogen cycle or Bethe's cycle and the proton–proton chain; different neutrinos are emitted by these two processes. Solar models based upon solar structure and composition of the central region have been derived to predict the different neutrino fluxes and their uncertainties. Two kinds of interaction between matter and neutrinos are theoretically possible and allow detection of solar neutrinos. Various experiments have been undertaken for looking at solar neutrinos but these have not yet been detected. An upper limit on the solar neutrino flux recently set permits the following conclusions: less than 9% of the Sun's energy is produced by the carbon–nitrogen cycle; and the temperature at the interior of the Sun is probably less than the temperature which was commonly accepted. (auth)

10268 OBSERVATION OF A SOLAR FLARE INDUCED INTERPLANETARY SHOCK AND HELIUM-ENRICHED DRIVER GAS. Hirshberg, J.; Alksne, A.; Colburn, D. S.; Bame, S. J.; Hundhausen, A. J. (Stanford Univ., Calif.). J. Geophys. Res.; 75: 1-15(1 Jan 1970).

On February 13, 1967, a class 3B solar flare occurred at 20°N, 10°W. The resultant disturbance in the solar wind was observed by the Los Alamos plasma probe on Vela 3A and Ames Research Center magnetometer on Explorer 33. The initial discontinuity in the solar wind was identified as a shock. The normal to the shock made an angle of 60° with the plane of the ecliptic. This extreme angle of tipping indicates that the shock from this flare did not propagate spherically from the Sun as described by simple theory. Nine hours after the shock passed, plasma containing 22% helium was observed. Since the solar wind normally contains 4% helium, this observation adds to the increasing body of evidence that flares occur in regions relatively rich in helium. The velocity of the solar wind continued to increase after the helium plasma passed, i.e., at 1 AU the helium-enriched material was still being propelled from behind. This observation is evidence that the plasma continued to be accelerated at the Sun for an extended period of time after the flash phase of the flare. (auth)

10269 INSTABILITIES ASSOCIATED WITH HEAT CONDUCTION IN THE SOLAR WIND AND THEIR CONSEQUENCES. Forslund, D. W. (Los Alamos Scientific Lab., N. Mex.). J. Geophys. Res.; 75: 17-28(1 Jan 1970).

Associated with the large heat conduction in the solar wind is a skewing of the ion and electron distribution functions. It is shown that this collisional skewing of the electron distribution function can linearly excite collisionless ion–acoustic, electrostatic ion cyclotron, magneto-acoustic, and ion cyclotron waves in the steady-state solar wind even though the net equilibrium current parallel to B is zero. The initial growth rates for these unstable waves are derived, and the effectiveness of the wave–particle interactions in heating the ions and in altering the thermal and electrical conductivities is discussed. (auth)

10270 ON THE ELECTRIC FIELD IN THE EARTH'S DISTANT MAGNETOTAIL. Van Allen, James A. (Univ. of Iowa, Iowa City). J. Geophys. Res.; 75: 29-38(1 Jan 1970).

Solar electrons of energy $E_e \geq 50$ keV are used as test particles for studying electric and magnetic fields in the distant magnetotail of the Earth. During the prolonged solar electron event November 10–22, 1967 (Van Allen and Ness, 1969), simultaneous observations were made with Explorer 33 in interplanetary space and with Explorer 35 as the latter crossed the magnetotail. On the basis of the fact that the intensity of electrons was nearly identical at successive pairs of observational points during a wide range of geomagnetic conditions, it is inferred (a) that $|\int_{A'}^{B} \mathbf{E} \cdot d\mathbf{s}| \leq$ 1.5 kilovolts where E is the vector electric field, from any cause, at a vector element ds of the trajectory of the particle and the line integral is taken along trajectories from source points A' outside the magnetosphere to a succession of points B across the magnetotail at about 64 R_E downstream; and (b) that, by using (a), data from Van Allen and Ness, and observations of the very short delay

time (±100 sec) in access of solar electrons into the central part of the magnetotail (impulsive event of August 14, 1968, as an example), solar electrons enter the magnetotail at downstream distances between 64 and 900 R_E. Otherwise stated, it appears that the magnetic topology of the distant magnetotail is an "open one" (dynamic interconnection to the interplanetary field) and that there are no closed electrical equipotential surfaces beyond 64 R_E. This evidence supports the idea that the motional electromotive force that results from the movement of the interplanetary magnetic field with respect to the Earth plays an essential role in magnetospheric physics, e.g., in driving magnetospheric convection, electrical currents in the polar ionosphere, etc. (auth)

10271 METHOD FOR ESTIMATING THE ELECTRICAL CONDUCTIVITY OF THE LUNAR INTERIOR. Sill, W. R.; Blank, J. L. (Bellcomm, Inc., Washington, D. C.). J. Geophys. Res.; 75: 201-10(1 Jan 1970).

A theoretical investigation of the lunar interaction with the solar wind and its electric and magnetic fields reveals a method for estimating the electrical conductivity of the lunar interior. Data from a single lunar surface magnetometer, in conjunction with simultaneous measurements of the interplanetary magnetic field and solar wind velocity, should provide sufficient information to distinguish between various classics of conductivity models. Such models are based on different thermal histories and assumed lunar materials. (auth)

10272 SOLAR BURSTS AT MILLIMETER WAVELENGTHS. Feix, G. (Univ., Bochum, Ger.). J. Geophys. Res.; 75: 211-18(1 Jan 1970).

Three limb bursts of exceptional intensity in the millimeter region are presented; the enhanced intensity of their flash phase showed a departure from those received from the solar disk. This behavior of a center of activity suggests a brightening at the limb On the disk, average temperatures 2.5×10^5 °K were obtained, whereas at the limb, burst temperatures from the same center of activity on the order of 2×10^6 °K were obtained. (auth)

10273 CHARACTERISTICS OF THE X-RAY AND Hα EMISSIONS ASSOCIATED WITH SOLAR PROTON FLARES. Sakurai, Kunitomo (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res.; 75: 225-7(1 Jan 1970).

It is shown that the rise time of both the x-ray and Hα emissions is closely related to the acceleration efficiency of solar cosmic-ray particles; namely, as this becomes shorter, the accelerated energy of solar cosmic rays tends to become higher. A clear-cut relation between this rise time and characteristics of solar cosmic rays is demonstrated. (W.D.M.)

10274 SUN SPOTS AND RADIO COMMUNICATION. Dieminger, Walter. Bild Wiss.; 6: 562-72(Jun 1969). (In German).

The influence of solar phenomena on the ionosphere and the resulting effects on radio communication are discussed. Seasonal variations in the E and F2 layers are noted, and attention is drawn to the influence of solar activity on the critical frequency of the F2 layer, which may reach as high, for example, as 34 MHz during active periods. Correlation with uv and visible light behavior may be made. The strength and frequency of the sporadic E layer, on the other hand, do not appear to be related to solar activity. The Moegel–Dellinger effect is discussed as the best understood disturbance as related to wave radiation. Proton effects observed until now have been correlated in every case with intensive chromospheric eruptions and must be the result of the same cause. Results are only correlative, and prediction of radio disturbances by sunspot observation does not appear to be possible. (BBB)

10275 INTERIOR STRUCTURE OF THE SUN. Rouse, C. A. (Gulf General Atomic Inc., San Diego, Calif.). Nature (London); 224: 1009-10(6 Dec 1969).

Reference is made to the solar neutrino experiment of Davis (Phys. Rev. Lett., 12: 302(1964)), in which the counting rate to be expected from ^8B solar neutrinos was an order of magnitude greater than the experimental background counting rate, but only the background counting rate was observed. Reasons are given why this null result is considered important, and evidence is presented that the various models of the solar interior used to predict the neutrino fluxes are significantly different from the structure of the real Sun. These reasons are concerned firstly with methods of solving the equilibrium equations in the envelope and with the boundary conditions used or approximated at the surface. In particular, the use of a perfect gas massless envelope results in a mean temperature gradient in the outer envelope which is significantly less than obtained in continuous solar models (CSMs); also the net result could be central densities higher than and central temperatures lower than those in the real Sun, and furthermore whereas any assumption that in the outer envelope the pressure varies with temperature as in a perfect gas is wrong, the continuous solar model calculations, which begin at the solar center, give excellent agreement with recent empirical models of the solar photosphere. This indicates also that the CSM calculations on the outer envelope are also correct, since they provide the "initial" conditions for the photosphere calculations. Secondly deviations from a perfect gas equation of state in the core as well as in the envelope and improvements in opacities used in the radiative temperature gradient could result in a significantly different density–temperature profile throughout the solar interior. Higher opacities could lead to higher central temperatures than are obtained in present models and could also yield a convective rather than a radiative core. It has also been shown that the predicted ^8B neutrino flux is sensitive to variations in pressure and opacity. A real-gas equation of state and self-consistent real-gas opacities are necessary for a more accurate model of the present Sun. Thirdly, recent determinations of the solar photospheric He abundance by prediction of continuum and line radiation from CSM photospheres indicate a probable abundance slightly less than 35% by mass; this is about twice that inferred from solar evolution calculations carried out after the Davis experiment and which were varied to yield a lower ^8B neutrino flux. The new flux prediction is about twice the background count. A high solar He abundance and a low ^8B neutrino flux appear to be mutually exclusive. It may be that the internal structure of the Sun is much more complex than has been thought, and it is suggested that a more accurate model of the present Sun must consider the possibility of gravitational separation of high-Z elements, leading to a higher abundance of these elements in the core than observed in the photosphere. With uncertainty in the understanding of the production of low-energy neutrinos, and the uncertainty in the probability of absorption of neutrinos by ^{37}Cl near threshold, the null result of the Davis experiment does not eliminate the carbon cycle as the dominant source of energy production in the Sun. Finally, some of the assumptions used in the theoretical calculations of the evolution of the Sun and other stars may need to be modified. (UK)

10276 THE SOLAR MINIMUM. NCAR (Nat. Center Atmos. Res.) Quart.; No. 23: 3p(May 1969).

Recent studies of the area of the solar temperature minimum show that this temperature is even lower than the adopted value of 4600 to 4700°K. Accurate measurements of the solar minimum temperature have been derived from the far ir portion (25 to 1000 μ) of the solar spectrum. The NASA Convair 990 jet research aircraft offered a stable platform providing sustained exposure at an altitude of 40,000 ft. Observations were made with the Sun 65° above the horizon while flying westward at a maximum speed of 600 mph at 42° north latitude to keep the Sun at an almost constant position for several hours. An improved interferometer was developed especially for the experiments; a Ge bolometer was used as detector. A photometric spectrum of the Sun from about 80 to 500 μ yielded the best measurements to date of the solar minimum, showing the temperature near the surface of the photosphere to be 4300 ± 200°K. This confirms earlier results of a study of lines of ionized Ca in the visible spectrum showing that the temperature at the solar minimum might be only 4000 to 4200°K. New information about trace constituents in the Earth's upper atmosphere was also obtained. Ozone, atomic O, hydrogen-bonded water molecules, and possibly nitrous oxide were identified. (BBB)

10277 SMALL-SCALE FLUCTUATIONS OF THE MAGNETIC FIELD OF THE INTERPLANETARY PLASMA. Lotova, N. A. (Lebedev Inst. of Physics, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 265-7(1969).

Translated from Geomagn. Aeron.; 9: 332-3(1969).

The statistical component of the interplanetary magnetic field is associated with different unstable processes in the plasma. The contribution of those magnetic-field fluctuations that are produced by anisotropic temperature instability is estimated. (W.D.M.)

10278 PROTON FLARE PROJECT, 1966. SUMMARY OF THE AUGUST/SEPTEMBER PARTICLE EVENTS IN THE MCMATH REGION 8461. Svestka, Z. (Astronomical Inst., Ondrejov, Czech.); Simon, P. Solar Phys.; 10: 3-59(Nov 1969).

The paper summarizes observations of solar and space phenomena related to the McMath region Number 8461 which passed over the solar disk during the 1966 Proton Flare Project period, from August 21 to September 4, and produced two important solar particle events on August 28 and September 2. The most important results are reviewed and interpretation of some of them is suggested. (W.D.M.)

10279 CLARIFICATION IN THE IDENTIFICATION OF CERTAIN LINES IN THE INFRARED SOLAR SPECTRUM. Montgomery, Earl F. (Univ. of Texas, Austin). Solar Phys.; 10: 60-2(Nov 1969).

Forty-two unidentified spectral lines in Mohler's (1955) table of infrared solar spectrum wavelengths are shown to be solar,

and three of these tentatively have been identified. One line, listed by Mohler as solar or telluric, is shown to be telluric. (auth)

10280 HIGH-RESOLUTION PHOTOGRAPHY OF THE SOLAR CHROMOSPHERE. VI. PROPERTIES OF THE BRIGHT MOTTLES. Bray, R. J. (CSIRO, Sydney). Solar Phys.: 10: 63-70(Nov 1969).

Bright chromospheric mottles observed at the Hα line center are found to have sizes ranging from 1450 to 4400 km and lifetimes of about 11 min. They occur in close juxtaposition to dark mottles which, at intermediate heliocentric angles (≈60°), are found to be displaced towards the limb relative to the associated bright mottles. The magnitude of the displacement indicates a height difference of 4300 km. In conjunction with height measurements of bright mottles beyond the limb (Loughhead, 1969), this implies that bright and dark mottles are phenomena of the lower (≲3300 km) and upper (≈5000 to 7600 km) chromosphere, respectively. (auth)

10281 HIGH-RESOLUTION PHOTOGRAPHY OF THE SOLAR CHROMOSPHERE. VII. STRUCTURE OF THE LOW CHROMOSPHERE. Loughhead, R. E. (CSIRO, Sydney). Solar Phys.: 10: 71-8(Nov 1969).

High-resolution observations of the low chromosphere beyond the limb at the center of the Hα line reveal the existence of two types of fine structure whose presence has hitherto been unobserved: (1) small bright features show a close correspondence in properties with the bright mottles on the disk and are unequivocally identifiable as the latter seen beyond the limb; and (2) a narrow dark band lying immediately above the photospheric limb whose physical significance is not yet clear. The discovery and identification of the bright mottles beyond the limb, taken in conjunction with recent observations of Bray (1969), lend further weight to the view that the chromospheric spicules are to be identified with the dark mottles seen on the disk. (auth)

10282 Ca II RESONANCE LINES IN NONHOMOGENEOUS CHROMOSPHERES. Beebe, Herbert A.; Johnson, Hollis R. (Indiana Univ., Bloomington). Solar Phys.: 10: 79-87(Nov 1969).

Profiles of the K line of Ca II are computed for a two-component solar chromosphere, chosen to simulate with a simple geometry the chromospheric supergranular network. Each component rises above the BCA photosphere, the boundary component representing the bright network with a sharp temperature rise and the cell component representing the darker region with an extended temperature minimum. Theoretical intensity profiles of the Ca II K core, calculated as weighted averages over the projected areas of the components, are produced for $\mu = 0.6$ and 0.3. The line source function and the optical depth are obtained from a self-consistent treatment of the steady-state and radiative transfer equations, with complete redistribution assumed for scattering in the line. The atomic model consists of two bound levels and a continuum. It is found that a 4600 K minimum can lead to the successful theoretical prediction of the observed limb darkening and 4300 K radiation temperature of the K1 feature only when very large values of turbulent velocity are assumed to exist in the cell region. (auth)

10283 A SOLAR SPICULE MODEL BASED UPON CALCIUM II K LINE RADIATIVE TRANSFER STUDIES. Avery, Lorne W.; House, Lewis L. (High Altitude Observatory, Boulder, Colo.). Solar Phys.: 10: 88-103(Nov 1969).

Monte Carlo radiative transfer techniques are used to develop a height-dependent spicule model based upon a more realistic configuration than has hitherto been considered. The spicule is represented by a uniform cylinder, of finite length, standing vertically upon a plane chromosphere. The observed, limb-darkened, anisotropic chromospheric flux incident upon the cylinder is incorporated into the transfer calculations. The resulting model is characterized by a random, line-broadening velocity of 20 km/sec, with electron temperature increasing from 6×10^3 K at the base to about 1.5×10^4 K at 11,500 km above the solar surface. The corresponding values of electron density are 8×10^{11} cm^{-3} and 4×10^{10} cm^{-3}. Contrast curves of the spicule model against the chromospheric background are computed and indicate that spicules should appear both bright and dark on the disk, depending upon their position with respect to the limb, the spectral frequency of observation and the viewing height. (auth)

10284 GAS-PRESSURE AND PRESSURE-STRATIFICATION IN THE SUNSPOT. Ruhm, H. (Landessternwarte, Heidelberg). Solar Phys.: 10: 104-11(Nov 1969).

By a curve of growth analysis, using photospheric and umbral equivalent widths, published by Fricke and Elsässer, and absolute oscillator strengths, it was found that the gas pressure in a sunspot is lower than in the corresponding layers of the photosphere. Contribution curves were computed to get more accurate information as to which layers of the spot the results relate; these were derived by comparing the damping parts and the linear parts of the photospheric and umbral curves of growth. From Mattig's observations of a sunspot near the limb, a scale height of about 300 km is derived. This indicates a deviation from the hydrostatic pressure stratification. From these empirical results—a similar indication is given by the discussion of the Wilson effect by other authors—the conclusion is drawn that it cannot be a satisfying method to construct a sunspot model by the a priori assumption of hydrostatic gas pressure, because it seems to hide effects not understood until now. One should try to develop an entirely empirical model with the aid of better observations. (auth)

10285 ON THE ABSENCE OF THE (0,0) C_2 SWAN BAND FROM SUNSPOT SPECTRA. Branch, David (Univ. of Maryland, College Park). Solar Phys.: 10: 112-14(Nov 1969).

It is suggested that, in accordance with molecular equilibrium predictions, the (0,0) C_2 Swan band does not appear in sunspot spectra. Earlier identifications may have been due to the influence of scattered photospheric light and random coincidences in line position. (W.D.M.)

10286 EXCITATION OF THE FORBIDDEN CORONAL LINES. Fe XIII λλ10747, 10798, AND 3388. Chevalier, R. A.; Lambert, D. L. (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Solar Phys.; 10: 115-34(Nov 1969).

The excitation of the lowest ($3s^23p^2$) configuration of Fe XIII is discussed for the range of density and temperatures experienced in the solar corona. The principal features are the introduction of proton collisions as an important mechanism for exciting the $3p^2\ ^3P$ levels, the use of improved electron collision strengths, and a detailed discussion of the influence of the excited configurations. The predicted intensity ratios are shown to be consistent with available observations with the single exception of an eclipse measurement of the ratio of the intensities of the infrared lines. (auth)

10287 NO EVIDENCE OF ANY SOLAR LIMB BRIGHTENING IN THE RANGE OF 3.5 MM TO 2 CM. Tlamicha, A. (Astronomical Inst., Ondrejov, Czech.). Solar Phys.: 10: 150-3 (Nov 1969).

The mapping of the Sun and its peculiar regions was done by using the 140-ft radio telescope on 2 cm at the NRAO, the 36-ft telescope on 3.5 and 4.5 mm at Kitt Peak, and the 120-ft telescope on 2 cm at MIT during the period March–July 1968. The half-power beam width on 3.5 mm, 4.5 mm, 2 cm (140-ft), and 2 cm (120-ft), was 1.4, 1.8, 2.0, and 2.3 min of arc, respectively. (W.D.M.)

10288 DIFFERENTIAL ROTATION OF THE SOLAR ELECTRON CORONA. Hansen, Richard T. (National Center for Atmospheric Research, Kamuela, Hawaii); Hansen, Shirley F.; Loomis, Harold G. Solar Phys.: 10: 135-49(Nov 1969).

Autocorrelation analyses of K-coronameter observations made at Haleakala and Mauna Loa, Hawaii, during 1964–1967 have established average yearly rotation rates of coronal features as a function of latitude and height above the limb. At low latitudes the corona was found to rotate at the same rate as sunspot, but at higher latitudes was consistently faster than the underlying photosphere. There were differences as large as 3 to 4% in the rate at specific latitudes from year to year and between the two hemispheres. In 1967 a nearly constant rotation was found for heights ranging from 1.125 to 2.0 $R_\odot$. For 1966 there was a more complicated pattern of height dependence, with the rate generally decreasing with height at low latitudes and increasing at high latitudes. (auth)

10289 MODEL OF THE MAGNETIZED SOLAR WIND. Urch, I. H. (Univ. of Adelaide). Solar Phys.: 10: 219-28(Nov 1969).

A steady-state, inviscid, single-fluid model of the solar wind in the equatorial plane is developed, using magnetohydrodynamics and including the heat equation with thermal conduction but no non-thermal heating (i.e., a conduction model). The effects of solar rotation and magnetic field are included enabling both radial and azimuthal components of the velocity and magnetic fields to be found in a conduction model for the first time. The magnetic field cuts off the thermal conduction far from the Sun and leads to an increased temperature at 1 AU and relatively small changes to the radial velocity and density. Models are found that fit the experimental electron densities in $2\ R_\odot < r < 16\ R_\odot$. These models predict at 1 AU a radial velocity of 300 to 380 km · sec^{-1} and a density of ≈8 protons · cm^{-3}. The latter velocity corresponds to a density profile obtained by Blackwell and Petford (1966) during the last sunspot minimum, and is about 100 km · sec^{-1} above that found in previous conduction models that fit the coronal electron

densities. The radial velocities are now consistent with the mean quiet solar wind, as are the densities when the experimental values are averaged over a magnetic sector. However, the azimuthal velocity at 1 AU is only 1 to 2 km · sec^{-1}, which is low compared to the experimental values as found by previous authors. (auth)

10290 SOLAR FLARE ALPHA TO PROTON RATIO CHANGES FOLLOWING INTERPLANETARY DISTRUBANCES. Lanzerotti, L. J.; Robbins, M. F. (Bell Telephone Labs., Murray Hill, N. J.). Solar Phys.; 10: 212-18(Nov 1969).

A discussion is presented on the half-hour-averaged low-energy solar alpha to solar proton flux ratios observed following the three large solar flares of May 23, 1967. One of the large changes observed in the particle ratios (following a sudden commencement (SC) storm observed on the Earth) is interpreted as due to a source effect. The second large change, again observed following an SC, is observed in the equal velocity and equal rigidity ratios and not in the equal energy/charge ratios. This observation suggests that electric fields in an interplanetary disturbance may be the cause of the modulations. (auth)

10291 NEUTRON MONITOR AND PIONEER 6 AND 7 STUDIES OF THE JANUARY 28, 1967 SOLAR FLARE EVENT. Bukata, R. P. (Southwest Center for Advanced Studies, Dallas); Gronstal, P. T.; Palmeira, R. A. R.; McCracken, K. G.; Rao, U. R. Solar Phys.; 10: 198-211(Nov 1969).

The January 28, 1967 solar flare event is discussed. High-energy data from several neutron monitor stations are supplemented by low-energy data from the interplanetary space probes Pioneers 6 and 7. A study of the data obtained from these three observation stations widely separated in solar azimuth has shown (1) the most probable location for the responsible flare was ≈60° beyond the western solar limb, (2) other than the large emitted particle flux, the phenomena associated with the January 28 activity are not atypical of other solar flare effects, (3) both the ≳0.5-GeV and ≳7.5-MeV fluxes observed at the Earth were isotropic, indicative of particle diffusion across the interplanetary magnetic field lines, (4) the spectral exponent of the differential rigidity spectrum at high energies was -4.8 ± 0.2, and (5) there was an indication of low-energy solar injection prior to the high-energy event of January 28. A technique is also described for obtaining the differential rigidity spectral index for an isotropic flux as a function of the relative enhancements of any pair of neutron monitors sufficiently separated in latitude. (auth)

10292 OUTSTANDING LYMAN-ALPHA EVENT. Monsignori Fossi, B. C.; Poletto, G.; Tagliaferri, G. L. (Osservatorio Astrofisico di Arcetri, Florence). Solar Phys.; 10: 196-7(Nov 1969).

During a solar flare on March 20, 1966 the Lyman-α flux was observed with an ion chamber mounted on SOLRAD 8. The aspect angle was 8.25°. The period of observation lasted from 09 5600 to 10 0400 UT. The expected temporal resolution, given by the revolution period of the satellite, because of the noise, was not achieved. (W.D.M.)

10293 MILLIMETER WAVE OUTBURSTS OF NOVEMBER 1 AND 2, 1968. Anastassiades, Michael; Macris, Constantin (National Observatory, Athens). Solar Phys.; 10: 188-95 (Nov 1969).

On November 1 and 2, 1968 two flares of importance 2B associated with the active region φ = S15°, L = 173° presented particular activity in the mm band. The outburst of November 1 in the mm wavelength band was of the gradual rise and fall type, while 24 hours later, the outburst of November 2 was of the sudden increase type with flux increase of the order of 4000 units. In the cm band the flare of November 1 produced a flux increase greater than in the mm band, while on November 2 the flare produced a series of outbursts with gradually increasing maxima, but much lower than the mm flux increase. It is reported that generally the peak flux decreases with increasing wavelength. The outburst of November 2 follows this rule but it is exactly the opposite for the sudden increase outburst produced by the November 1 flare. As to whether an increased brightness produces a higher mm or cm flux increase, available observations are not sufficient to make a firm statement. (auth)

10294 RADIO-EMISSION AND Ca-BRIGHTNESS OF TWO OUTSTANDING ACTIVE REGIONS DURING THEIR LIFETIME. Feix, G. (Univ., Bochum, Ger.). Solar Phys.; 10: 184-7 (Nov 1969).

The observations considered were focused on restricted solar areas at optical as well as mm and dm wavelengths. Apart from optical emission, only radio emission at mm wavelengths has its origin in the chromosphere, the same region where areas are activated before a plage is formed. (W.D.M.)

10295 RELATION BETWEEN THE INDICES OF SOLAR ACTIVITY IN THE PHOTOSPHERE AND THE CORONA. Xanthakis, John (Research Center for Astronomy and Applied Mathematics, Athens). Solar Phys.; 10: 168-77(Nov 1969).

A new index of solar activity in the photosphere is introduced, i.e., the areas index I_a defined with the help of the relation $I_a = \frac{1}{2}[\sqrt{A} + \sqrt{f}]$, where A and f are the total areas of the sunspots and faculae respectively corrected for foreshortening. A relation of the form: $S_\odot = S_0 + K[1 + \sqrt{10^{-2} I_F}]I_a$ is proposed, where $S_\odot$ represents the intensity of solar radio emission in the frequency range $1000 \leq f < 10{,}000$ MHz, I_F is the index of solar flares, S_0 is the corresponding value of $S_\odot$ for $I_a = 0$ and K is a constant. A relation of the form: $I_{5303} = I_0 + K[1 + \sqrt{N_{PF}}]I_a$ is proposed, where I_{5303} is the mean intensity of the coronal line 5303 Å for each quarter of the years 1954–1964, N_{PF} is the corresponding number of proton flares, I_0 is the value of I_{5303} corresponding to $I_a = 0$ and K is a constant. (auth)

10296 THE SOLAR (STELLAR) WIND AS A ONE-DIMENSIONAL FLOW. PART I. Grzedzielski, Stanislaw. Postepy Astron.; 17: 337-46(Dec 1969). (In Polish).

The solar-wind phenomenon is discussed in terms of a one-dimensional, stationary gas flow (de Laval nozzle problem). The influence of rotation and of the magnetic field upon the solar-wind model with heat conduction is also discussed in the case when spherical symmetry applies to the ecliptic plane. (auth)

10297 PHYSICS OF THE SUNSPOTS. PART I. Jakimiec, Jerzy. Postepy Astron.; 17: 315-35(Dec 1969). (In Polish).

Recent investigations of the structure of the solar atmosphere in sunspots, based on spectrophotometric measurements, are reviewed. (auth)

10298 ENHANCED BLACK-BODY RADIATION AS A GENERATING MECHANISM FOR WHITE-LIGHT SOLAR FLARES. Najita, Kazutoshi. Honolulu, Hawaii; Univ. of Hawaii (1969). 160p.

Thesis.

A white light flare is a rare impulsive event observed in the visible continuum radiating from localized regions during the early explosive stage of a few solar flares. A self-consistent model is developed which attempts to explain the white light flare in terms of an enhanced local black-body radiation due to a temperature perturbation at about optical depth unity in the photosphere. Solar cosmic-ray and radio observations indicate that energic protons and electrons are generated during the early phase of a solar proton flare. The model assumes a blast of energetic electrons and protons in equal numbers in the 10- to 1000-MeV range, incident on the photosphere from above, releasing most of its energy to the ambient gas at about the depth one sees the normal photospheric continuum radiation. This is interpreted by the study in terms of a temperature perturbation of the layer and a reradiation of the energy from an optically thin medium with a radiative relaxation time of several seconds and a radiation temperature of several hundred degrees above the normal. (TSS) (Diss. Abstr.)

10299 SPECTRUM OF GRANULAR AND INTERGRANULAR REGIONS. Howard, R.; Bhatnagar, A. (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Solar Phys.; 10: 245-53(Dec 1969).

A very high-quality wiggly-line spectrogram was analyzed by making high-resolution spectral scans of numerous small solar features. An attempt from the line profiles to detect a magnetic field difference between the granular and intergranular regions, resulted in a field increase of 20 ± 15 G in the darker regions of the granular field. Line width increases apparently due to small-scale turbulent velocities are seen in the darker regions. It is postulated that, in general, darker regions show increased turbulent velocities. Conspicuous asymmetries in line profiles are seen in dark intergranular regions. It is suggested that these are the result of velocity gradients in the downward flow of material. An ionized Cr line showed a conspicuous increase in equivalent width in the darker regions of the granular field, thus indicating a decrease in electron pressure in these areas. (auth)

10300 STUDIES OF GRANULAR VELOCITIES. I. GRANULAR DOPPLER SHIFTS AND CONVECTIVE MOTION. Mattig, W.; Mehltretter, J. P.; Nesis, A. (Fraunhofer Institut, Freiburg i.B.). Solar Phys.; 10: 254-61(Dec 1969).

The two available methods for determining the rms amplitude of the granular convective velocity field, namely the interpretation of line profiles, and direct measurements of velocity fluctuations in highly resolved spectra, give values (~2 km/sec, and ~0.4 km/sec, resp.) which are apparently inconsistent both in magnitude and in their dependence upon optical depth. Both theoretical and

observational evidence is given for the working hypothesis, that the best-resolved spectra mainly show velocity fluctuations due to the oscillation of the solar atmosphere, whereas the contribution of the granular velocity field is greatly reduced because of atmospheric seeing and can be found only as a weak superposition to the oscillatory velocity field. Realistic assumptions for the typical size of the granulation (2".5) and for the "seeing parameter" (1"), together with a simplified model of the granular velocity field, lead to correction factors of 30 to 40 between the true and observed amplitudes of the granular velocities. (auth)

10301 PROFILES OF FRAUNHOFER LINES IN THE PRESENCE OF ZEEMAN SPLITTING. II. ZEEMAN MULTIPLETS FOR DIPOLE AND QUADRUPOLE RADIATION. Beckers, J. M. (Air Force Cambridge Research Labs., Sunspot, N. Mex.). Solar Phys.; 10: 262-7(Dec 1969).

The radiative transfer equations (LTE) in the four Stokes parameters are derived for the general case of a Zeeman multiplet for both electric and magnetic dipoles, as well as for electric quadrupole radiation. (auth)

10302 LINE FORMATION IN A MAGNETIC FIELD. Rees, David E. (Univ. of Sydney). Solar Phys.; 10: 268-82(Dec 1969).

The effect of noncoherent scattering is examined for an absorption line formed in a uniform magnetic field. It is shown that the Stokes parameters of the line radiation may be computed by using the line source function in the absence of a magnetic field as a first approximation for that in the presence of a magnetic field. (auth)

10303 MAGNETOGRAPH MEASUREMENTS WITH TEMPERATURE-SENSITIVE LINES. Harvey, J.; Livingston, W. (Kitt Peak National Observatory, Tucson, Ariz.). Solar Phys.; 10: 283-93(Dec 1969).

Certain discrepancies between theoretical and empirical calibrations of magnetograph response are resolved by recognizing the existence of line profile changes in magnetic regions. Many of the photospheric lines commonly used for magnetic-field measurements weaken greatly in magnetic regions outside of sunspots. Unless due account is made of the line profile change, the magnetograph measurements underestimate magnetic flux and field strengths. The 5250.2 Å line is especially sensitive to weakening in magnetic regions. Measurements made with this line underestimate the true field by a factor ranging from about two on the linear portion of the profile to five near the line core. (auth)

10304 OBSERVATIONAL EVIDENCE FOR QUANTIZATION IN PHOTOSPHERIC MAGNETIC FLUX. Livingston, W.; Harvey, J. (Kitt Peak National Observatory, Tucson, Ariz.). Solar Phys.; 10: 294-6(Dec 1969).

Observations are presented which suggest that away from sunspots photospheric magnetic flux is quantized. Assuming the elemental area of a magnetic region to be 1 (arc-sec)^2 the elemental field strength is 525 G. (auth)

10305 MULTICHANNEL MAGNETOGRAPH OBSERVATIONS. I. COMPARISON WITH SPECTROHELIOGRAMS. Frazier, Edward N.; Scherrer, Philip H. (Univ. of California, Berkeley. Kitt Peak National Observatory, Tuscon, Ariz.). Solar Phys.; 10: 297-310(Dec 1969).

A new technique for displaying magnetograph observations is presented and applied to the 12-channel magnetograph at Kitt Peak National Observatory. Using the data from a raster scan, a digital "spectroheliogram" is constructed on the face of a cathode-ray and photographed. This enables one to recognize patterns in magnetograph data as easily as with conventional photographs. Comparisons with simultaneous spectroheliograms show no qualitative differences and indicate that the magnetograph is quite capable of studying morphology of individual solar features. (auth)

10306 THE FORBIDDEN LINE [Ca II] λ 7323 IN THE FRAUNHOFER SPECTRUM. Lambert, D. L. (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena); Mallia, E. A. Solar Phys.; 10: 311-14(Dec 1969).

New observations of the [Ca II] λ 7323 Fraunhofer line are reported. The blending H_2O line was weak at the time of observation. Accurate estimates of the center–limb variation of the equivalent width of the [Ca II] transition are obtained and shown to be consistent with the calcium abundance log N(Ca) = 6.33. (auth)

10307 ABUNDANCE OF CADMIUM IN THE SOLAR ATMOSPHERE. Hauge, Oeivind (Univ. of Oslo). Solar Phys.; 10: 315-18(Dec 1969).

The solar spectrum at 3261 Å was studied using the spectrograph at the Oslo Solar Observatory. From analysis of this wavelength region and recent results at 5085 Å, a solar cadmium abundance $\log N_{Cd} = 1.86 \pm 0.15$ was obtained. (auth)

10308 IDENTIFICATION OF SiH LINES IN THE SOLAR DISK SPECTRUM. Sauval, A. J. (Royal Belgian Observatory, Uccle-Brussels). Solar Phys.; 10: 319-29(Dec 1969).

A new investigation of the presence of SiH lines in the solar disk spectrum was performed. It may be concluded that molecular absorption lines of SiH are present in the disk spectrum with maximum equivalent widths of about 2 mÅ. A value of the oscillator strength of SiH was derived ($f_{00} = 0.0008 \pm 0.0004$). (auth)

10309 FAR-INFRARED MEASUREMENT OF THE SOLAR MINIMUM TEMPERATURE. Eddy, John A.; Lena, Pierre J.; MacQueen, Robert M. (National Center for Atmospheric Research, Boulder, Colo.). Solar Phys.; 10: 330-41(Dec 1969).

Radiometric measurement of the brightness temperature of the mean solar disk was made in the wavelength range from 238 to 312 μ using a Michelson interferometer of resolution 0.25 cm^{-1}, carried on the NASA research aircraft at 12.6 km. A mean temperature 4370 ± 260 K was obtained. The result is compared with other measurements of the solar minimum temperature and with the prediction of the BCA Model. (auth)

10310 MEASUREMENTS IN THE SOLAR SPECTRUM BETWEEN 1400 AND 1875 A WITH A ROCKET-BORNE SPECTROMETER. Parkinson, W. H.; Reeves, E. M. (Harvard Coll. Observatory, Cambridge, Mass.). Solar Phys.; 10: 342-7(Dec 1969).

Intensity measurements in the solar continuum throughout the wavelength range 1400 to 1875 Å are reported for a rocket flight from White Sands, New Mexico at 16:31 h UT on September 24, 1968. These intensities are approximately a factor of 3 lower than other published estimates and suggest a solar temperature minimum of 4400 K or lower which is in agreement with infrared observations. (auth)

10311 ENERGY DISSIPATION OF FAST HYDROMAGNETIC SHOCK WAVES IN THE SOLAR CHROMOSPHERE. Maeckle, R. (Univ., Tuebingen, Ger.). Solar Phys.; 10: 348-56(Dec 1969).

MHD equations including dissipation terms are applied to study the most important irreversible processes occurring in fast hydromagnetic shock waves under the conditions of the outer solar atmosphere. The atmosphere is assumed to be permeated by a nearly horizontal, uniform magnetic field, the magnitude and inclination angle of which being parameters of the analysis. Numerical examples, corresponding to situations which might occur in the upper chromosphere, are computed in order to demonstrate the procedure. (auth)

10312 THE INTENSITY, VELOCITY, AND MAGNETIC STRUCTURE OF A SUNSPOT REGION. V. ON THE GRADIENTS OF TEMPERATURE AND PRESSURE IN SUNSPOTS. Wittmann, A.; Schroeter, E. H. (Univ., Goettingen, Ger.). Solar Phys.; 10: 357-69(Dec 1969).

High-resolution sunspot photographs in the blue, red, and infrared continuum exposed on various days were used to derive the center-to-limb variation of the intensity ratio $\phi = I_{sp}/I_{ph}$. Special care was taken to correct for image blurring, scattered light, and the influence of line absorption. The observed increase of specific umbral intensities ϕ_u towards the limb leads to an extremely small temperature gradient in the umbra. From geometrical changes of the profiles (Wilson effect), an umbral depression of about 650 km and a density scale height of about 450 km were derived when H^- is assumed to be the predominant source of absorption. The penumbral depression was found to be 50 km or less. The density scale height of the umbra as computed from the observed temperature distribution is 80 km in the case of hydrostatic equilibrium. It is concluded that either magnetic pressure components produce deviations from hydrostatic equilibrium or that another source of absorption, dominating in the outer layers, has to be taken into account. (auth)

10313 STRUCTURE OF A SUNSPOT. V. WHAT IS THE WILSON EFFECT. Wilson, P. R. (Joint Inst. for Lab. Astrophysics, Boulder, Colo.); McIntosh, P. S. Solar Phys.; 10: 370-83(Dec 1969).

From enlargements of patrol photographs of the disk passage of the sunspot of July 20–August 2, 1966, intensity profiles across the spot are obtained at several positions near the disk center and at each limb. It is found that these profiles show asymmetric features near each limb (increasingly sharp limb-side penumbra and poorly resolved disk-side penumbra) which are similar to those reported in Paper III of this series. It is suggested that these profile asymmetries are the essential feature of the center–limb variations in the appearance of a sunspot which have become known as the Wilson effect. Conventionally the Wilson effect is described as the extreme foreshortening and eventual disappearance of the disk-side penumbra and, recently, Suzuki has referred to this as the

occultation of the penumbra by the photosphere. No evidence at all is found for the disappearance of the disk-side penumbra at the limb in this spot. Defining half-height points on the profile curves as the umbral and penumbral boundaries, it is found that, near the west limb where the spot is stable and regular, the limb-side penumbra increases by about 10% at the expense of the umbra. This result qualitatively supports the results reported in Paper III although it is smaller in magnitude. Other observations of sunspots which appear to exhibit the conventional Wilson effect are discussed and it is concluded that in no case yet published is the resolution and seeing of sufficient quality to demonstrate unambigously the disappearance of the disk-side penumbra. (auth)

10314 THE INTENSITY, VELOCITY, AND MAGNETIC STRUCTURE OF A SUNSPOT REGION. IV. PROPERTIES OF A UNIPOLAR SUNSPOT. Beckers, J. M. (Air Force Cambridge Research Labs., Sunspot, N. Mex.); Schroeter, E. H. Solar Phys.; 10: 384-403(Dec 1969).

From an investigation of spectra in a magnetically sensitive (λ 6173, g = 2.5) and insensitive line (λ 5576, g = 0), the following properties for a symmetrical sunspot were derived: (a) The magnetic field strength varies with the distance q($q \leq 1$) from the sunspot center like $H(q) = H(0)(1 + q^2)^{-1}$. (b) The zenith angle of the magnetic field varies like 90°q. From this and from H(q) a height gradient of 0.5 gs/km at q = 0 is found. (c) The equivalent width and the half width of λ 5576 show an increase in penumbral regions of maximum Evershed flow. Most likely this is due to a combination of inhomogeneities in the Evershed flow and "microturbulence." (d) The magnetic field strength is found to be larger in the dark interfilamentary regions of the penumbra. These regions move downwards with respect to the bright filaments and probably have a more horizontal magnetic field. (e) In a weak light bridge and in extensions of bright penumbral filaments into the umbra, a decrease of the magnetic field strength, and a more horizontal field direction with respect to the umbral surrounding, are found. (f) In umbral dots and in the light bridge a relative upward motion is found. (auth)

10315 PROPERTIES OF UMBRAL DOTS. Wilson, P. R. (Univ. of Sydney). Solar Phys.; 10: 404-15(Dec 1969).

On the basis of a three-dimensional radiative transfer analysis of several models it is shown that bright structures in sunspot umbrae which have horizontal diameters of 300 km or less cannot extend more than 300 km down into the umbra. Thus, such models are inconsistent with the hypothesis that the bright features are due to convection from the deep regions of the umbra. No such restrictions can be applied if the surface diameter is of order 500 km, but a model of this type is shown to be inconsistent with the available data. Thus a convective explanation of these bright features appears to be ruled out. A model having a diameter of 200 km is shown to be consistent with the available observations but these are not sufficiently precise to warrant any strong claim for the validity of this model. The features of this model are described and it is shown that near the limb the apparent brightness of these features compared to the umbral background should increase. However, order-of-magnitude calculations show that there is some doubt whether joule heating can account for the nonradiative energy requirements of this model. (auth)

10316 ISOPHOTAL PHOTOMETRY AND MORPHOLOGICAL CHANGES IN THE FLARES. Dizer, M. (Kandilli Observatory, Istanbul). Solar Phys.; 10: 416-28(Dec 1969).

Measurements made on the brightness in Hα of all parts of the flare photographed through a birefringent filter centered on Hα, using a scanning isodensitometer, are reported. From obtained isophotes of the flares some information was derived on the morphological changes in the flare and the total energy in Hα of the flare was estimated. (auth)

10317 OBSERVATIONS ON THE TIME STRUCTURE OF SOLAR RADIO BURSTS AT A WAVELENGTH OF 12 M. Sastry, Ch. V. (Astrophysical Observatory, Kodaikanal, India). Solar Phys.; 10: 429-32(Dec 1969).

Extensive observations on the time structure of solar radio bursts of Type I have been made in the frequency range 100 MHz and above. Many important conclusions regarding the generation and propagation of these bursts have been arrived at on the basis of these observations. It is important to test the validity of these conclusions at lower frequencies. In this note, results of observations made at a frequency of 25 MHz are reported. (W.D.M.)

10318 IOWA CATALOG OF SOLAR X-RAY FLUX (2 TO 12 A). Drake, Jerry F. Sr.; Gibson, Jean; Van Allen, James A. (Univ. of Iowa, Iowa City). Solar Phys.; 10: 433-59(Dec 1969).

The absolute x-ray flux from the whole disc of the sun in the wavelength range 2 to 12 Å was observed for a prolonged period by University of Iowa equipment on the earth-orbiting satellite Explorer 33 and the moon-orbiting satellite Explorer 35, both of the Goddard Space Flight Center of the National Aeronautics and Space Administration. The observations were continuing at the date of writing (July 1969). A comprehensive catalog of the flux F(2 to 12 Å) was being produced. The observational technique and the scheme of reducing data are described in this article. Sample tabulations and plots are given. A catalog of tabular and graphical data with a time resolution of either 81.8 or 163.6 sec is presented for two observational periods. (auth)

10319 RADIO EVIDENCE OF DIRECTIVE SHOCK-WAVE PROPAGATION IN THE SOLAR CORONA. Kai, K. (CSIRO, Sydney). Solar Phys.; 10: 460-4(Dec 1969).

Radioheliograph observations at 80 MHz are reported of a flare-associated event in which two type II bursts occur in four different sources. The projected centers of the sources lie along an arc subtending an angle of about 150° at the optical flare center. If the arc represents the projection on the Sun's disk of a shock front passing through the 80 MHz plasma level, the source configuration suggests that the shock wave has originated from the optical flare region and propagated into the corona within a limited cone. On the opposite side of the flare center, outside the shock cone, there was a stable bipolar source. Strong magnetic fields in this source may have acted as a "magnetic wall" to the shock wave and inhibited its propagation in this direction. (auth)

10320 SEARCH FOR ENERGETIC NEUTRONS EMITTED DURING SOLAR FLARES. Daniel, R. R.; Gokhale, G. S.; Joseph, G.; Lavakare, P. J.; Sekhon, B. S. (Tata Inst. of Fundamental Research, Bombay). Solar Phys.; 10: 465-71 (Dec 1969).

On the basis of solar-flare forecasts, balloon flights were made from Hyderabad, India (vertical geomagnetic threshold rigidity of 16.9 GV), to detect the possible emission of high-energy neutrons during solar flares. The detector consisted of a central plastic scintillator, completely surrounded by an anticoincidence plastic scintillator shield. The instrument responds to neutrons of about 15 to 150 MeV and gamma rays of about 5 to 30 MeV with about the same efficiency. The detector was flown to an atmospheric depth of 25 g cm^{-2} on February 26, 1969; while the balloon was at ceiling a flare of importance 2B and one of 1N occurred. No perceptible flare associated increase in the counting rate was observed. Using the observed counting rates, an upper limit of 1.2×10^{-2} neutrons cm^{-2} sec^{-1} is obtained for the first time for a flare of importance 2B for neutrons of energy 15 to 150 MeV. The corresponding upper limit for gamma rays of energy 5 to 30 MeV is found to be $\sim 10^{-2}$ photons cm^{-2} sec^{-1}. The neutron flux limits are compared with the recent calculations of Lingenfelter. (auth)

10321 THE MAINTENANCE OF SOLAR DIFFERENTIAL ROTATION BY TWO-DIMENSIONAL TURBULENCE. A NUMERICAL MODEL. Nickel, George H. (Air Force Weapons Lab., Kirtland AFB, N. Mex.). Solar Phys.; 10: 472-5(Dec 1969).

A numerical model has been made to test the theory that solar differential rotation is maintained by the "countergradient transport" of energy peculiar to two-dimensional turbulence. After a brief discussion of this turbulent process, the numerical methods employed and their application to the Sun are reviewed. The results of one problem are presented, indicating that this model can represent the observed large-scale nature of the Sun's surface. (auth)

10322 THE SOLAR DIFFERENTIAL ROTATION AND ROSSBY-TYPE WAVES. Kato, Shoji; Nakagawa, Y. (National Center for Atmospheric Research, Boulder, Colo.). Solar Phys.; 10: 476-93(Dec 1969).

It has been suggested that the solar differential rotation might be maintained by nearly horizontal nonspherical convective circulation called Rossby-type waves (the wave motions characterized by the close balance of the Coriolis force and pressure gradient in horizontal motions). In this paper, such Rossby-type waves which could be excited in the upper solar convection zone are considered, and the possibility of maintenance of the solar differential rotation by such waves is examined. A numerical estimate, in terms of the rate of conversion of the kinetic energy of such wave motions into the mean rotational motion, indicates this possibility. The implications and limitations of the results are also discussed. (auth)

10323 A POSSIBLE CONNECTION BETWEEN N-S AND E-W SOLAR ASYMMETRIES. Godoli, G. (Osservatorio Astrofisico, Catania, Italy); Poletto, G. Solar Phys.; 10: 494-5(Dec 1969).

A possible connection is pointed out between north–south and east–west solar asymmetries. (W.D.M.)

10324 SOME CHARACTERISTICS OF THE SOLAR WIND INFERRED FROM THE STUDY OF SODIUM EMISSION FROM COMETARY NUCLEI. Bappu, M. K. V.; Sivaraman, K. R. (Kodaikanal Observatory, India). Solar Phys.; 10: 496-501 (Dec 1969).

Seventeen comets, having information on sodium D-line emission during their apparition, have been studied. The heliocentric distances corresponding to the sodium emission commencement or termination epoch are found to have a dependence on the phase of the solar cycle. For comets appearing during a solar maximum the sodium emission is detectable out to greater distances than for the comets appearing during solar minimum. The sodium emission is also found to depend on heliographic latitude of the comet. It is concluded that the spatial properties of the solar wind during a solar maximum and minimum are responsible for the observed dependence. (auth)

10325 EARLY DESPINNING OF THE SUN. Schwartz, K. (American Nucleonics Corp.; Glendale, Calif.); Schubert, G. Astrophys. Space Sci.; 5: 444-7(Dec 1969).

It is shown that if the Sun passed through a T Tauri stage, then a mass loss of only 15% would be sufficient to despin the Sun to an angular velocity of $0(10^{-5}$ rad/sec) at 10^7 years without the additional braking effect of an enhanced magnetic field. Thus, the present Sun could have a core rotating, at most, ten times faster than its surface. (auth)

10326 RELATION BETWEEN METRIC AND DECAMETRIC NOISE STORM ACTIVITY. Boischot, A.; De la Noe, J.; Moeller-Pedersen, B. (Observatoire, Meudon, France). Astron. Astrophys.; 4: 159-60(Jan 1970).

The meter type-I storms are generally accompanied by decameter continuums interpreted as type-III storms. It is suggested that the two kinds of storms are generated by the same high-energy electrons streaming outwards from the photosphere or low chromosphere. (auth)

10327 DEPRESSION OF THE SOLAR CONTINUOUS SPECTRUM BY LINE ABSORPTION AND THE BALMER CONTINUUM. Holweger, H. (Univ., Kiel). Astron. Astrophys.; 4: 11-17(Jan 1970).

It is shown that line absorption, mainly due to faint Fraunhofer lines ($W_\lambda \lesssim 5$ mÅ), can account for the difference between the observed flux of solar radiation and model predictions in the wavelength range 3300 to 5000 Å. Shortward of 4000 Å, several faint lines may lay within 0.1 Å, thus producing a quasi-continuous absorption of 10% or more. Equivalent widths W_λ of these lines cannot be measured individually; they are predicted by means of laboratory-intensity tables. Other, measurable solar lines of the same element were used to transform laboratory intensities into solar W_λ. In the region 3647 to 4000 Å strong lines are also important, especially merging high members of the Balmer series and Ca II H + K. Despite rather large uncertainties connected with predicted lines, calculated corrections for the absorption due to all lines lead to good agreement between the observations of Labs and Neckel (1968) and the flux calculated according to solar models which are fitted to the observed flux at $\lambda \gtrsim 6000$ Å. The solar Balmer jump appears to be completely hidden by line absorption. It seems therefore impossible to determine its value, D, from spectrograms alone, i.e., without detailed line-absorption analysis. The calculations are consistent with D = 0.13 but are still not reliable enough to be used as a model criterion. (auth)

10328 RAPID MAPPING OF SOLAR MAGNETIC FIELDS. Michard, R.; Rayrole, J. (Observatoire de Paris, Meudon, France). Astron. Astrophys.; 4: 36-9(Jan 1970). (In French).

A spectroheliographic technique giving images of active regions is described, whereupon the longitudinal field appears as a system of interference fringes. The lower level of detection is about 20 gauss, the resolution 3", the angular field registered in 5 minutes is $10' \times 12'$. This method is useful when one needs immediately qualitative information on the magnetic structure of active regions, e.g., in short-term forecasting of flare activity. (auth)

10329 IONIZATION ENERGIES AND OSCILLATOR STRENGTHS FOR Fe XVI, Co XVII, AND Ni XVIII. McEachran, R. P.; Tull, C. E.; Cohen, M. (York Univ., Toronto). Astron. Astrophys.; 4: 152-5(Jan 1970).

Theoretical ionization energies for a number of doublet S, P, D, and F states of three highly ionized members of the sodium isoelectronic sequence were calculated by means of the frozen-core approximation. The maximum discrepancy between theoretical and experimental values occurs for the ground state of Ni XVIII, and amounts to 1.02%. The discrepancies for Fe XVI and Co XVII are all much smaller. The frozen-core orbital wave-functions were employed to calculate oscillator strengths for all permitted electric dipole transitions between the various states, using both length and velocity formulations of the transition matrix element. The resulting values are generally in good agreement with each other, and may be helpful in the analysis of some Fe XVI lines observed in the solar corona. (auth)

10330 MAGNETIC FIELD CONFIGURATIONS IN ACTIVE REGIONS AS DERIVED FROM PERSPECTIVE EFFECTS. Ribes, E. (Observatoire, Meudon, France). Astron. Astrophys.; 4: 70-4(Jan 1970).

The perspective effect was used to determine the vector field of the active region (250° L, 8° b) from a sequence of longitudinal component observations. For this purpose, the perspective effect on a magnetic configuration calculated by the current-free approximation was studied. The longitudinal component observed every day and the corresponding calculated one were compared. The reasonably good agreement between them and the stability of the spots in white light lead to the conclusion that the magnetic changes are chiefly due to the center-to-limb effect. Because of the relative stability of the active region, it is, then, possible to obtain the east–west component from the center-to-limb effect. By comparing it with the E–W component deduced from the current-free approximation, some discrepancies were found which confirm that the observed magnetic lines are more bent on the solar surface than the calculated magnetic lines. (auth)

Galaxies

Refer also to abstract 10401.

10331 (P-4198(RAND)) AGE OF COSMIC RAYS AND ABUNDANCE OF ANTIMATTER IN OUR GALAXY. Libby, L. Marshall (Colorado Univ., Boulder. RAND Corp., Santa Monica, Calif.). Sep 1969. 7p.

Acceptance of a disc–halo structure for the Galaxy together with cosmic-ray evidence leads to the conclusion that cosmic rays are very old, older than 100 million years, and to the conclusion that the abundance of antimatter in the entire Galaxy is less than 3×10^{-4}. (auth)

10332 SYNCHROTRON EMISSION FROM THE GALAXY AND THE DIFFUSE X-RAY BACKGROUND. Hamilton, P. A.; Francey, R. J. (Univ. of Tasmania, Australia). Nature (London); 224: 1090-2(13 Dec 1969).

Measurements of the low-resolution, low-frequency, radio spectra in the direction of the galactic poles show a significant difference between the two hemispheres, and comparative spectra for the north and south galactic poles are shown. The brightness S as a function of frequency z between 10 and 150 MHz is well described by $S \propto Z^{-\alpha}$, where the spectral index α has values $\simeq 0.4$ for the north galactic halo and $\simeq 0.6$ for the south galactic halo. The galactic radio spectrum at these frequencies is usually explained as synchrotron emission from cosmic-ray electrons in the galactic magnetic field, and assuming a galactic magnetic field strength of ~2 μG, it is found that the electrons responsible for the observed spectra have energies in the range 0.5 to 2 GeV. The electron distributions for the north and south galactic poles implied from the radio spectra can be interpreted in one of two described ways, the first of which implies substantially different field strengths in the two galactic hemispheres and the other implies real differences in the electron distributions in the two regions. Discrimination between these two models requires observations of a phenomenon which is a function of the electron distribution without involving the magnetic field; such a phenomenon is the generation of x rays and γ rays by the inverse Compton effect. In a field of 2 μG and with 3°K black-body radiation, 1-GeV electrons will produce synchrotron emission at 30 MHz and x-ray photons at ~3.6 keV, and the spectra of both emissions will show the same dependence on the electron energy spectrum. An attempt was made to explain the diffuse x-ray background in terms of the inverse Compton effect from electrons and 3°K black-body photons in the galactic halo (Felten and Morrison, Astrophys. J. 146: 686 (1966)), but it was concluded that the observed x-ray background exceeded the possible halo emission and it was proposed that the diffuse background has its origin in intergalactic space. A recent analysis of six surveys of the southern sky in the range 2 to 150 MHz led to a rather different model and the finding that the emission originating in the halo is much brighter than assumed by Felten and Morrison, together with a much higher value for the specific intensity of the Compton scattered photons. The component of the x-ray background generated in the galactic halo should have an anisotropic distribution within one galactic hemisphere and a difference in spectral index from one hemisphere to the other. The observed x-ray intensity will be the sum of contributions from the intergalactic medium, extragalactic sources, the halo, and other processes operating in the Galaxy. The inter-

stellar absorption of x rays generated outside the galactic disk will become important in directions which include dense clouds of neutral hydrogen. Observation of the predicted anisotropy and difference in spectral index will depend on the relative magnitude of these processes. Measurements of the diffuse x-ray background between 1 and 10 keV for which spectral and directional information is available are summarized, all measurements being from rocket flights above the atmosphere. The problems in comparing data from different experiments are emphasized. A remarkable correspondence was found between the spectral indices of the radio and x-ray emissions in the polar directions and, in view of the revised intensity calculations, the possibility of a substantial x-ray flux generated in the galactic halo cannot be excluded. (UK)

10333 INTERSTELLAR GAS AND FIELD. Parker, E. N. (Univ. of Chicago).; Lerche, I. Comments Astrophys. Space Phys.; 1: 215-19(Nov-Dec 1969).

The extreme inhomogeneity of the tenuous interstellar gas is the result of a number of instability effects. A survey is presented of the work that has been done on the whole picture, including thermal effects, but with particular emphasis on the dynamical effects of the magnetic fields and cosmic rays. (W.D.M.)

10334 UPPER LIMIT TO RADIATION OF MASS ENERGY DERIVED FROM EXPANSION OF GALAXY. Sciama, D. W.; Field, G. B.; Rees, M. J. (Cambridge Univ., Eng.). Phys. Rev. Lett.; 23: 1514-15(29 Dec 1969).

Loss of mass energy from the Galaxy, whether by gravitational radiation or otherwise, should cause the Galaxy to expand. Observations of stellar motions near the Sun imply that the rate of radiation averaged over the last $\sim 10^9$ yr must be less than $200 M_\odot$ yr^{-1}. Studies based on the 21-cm line have already yielded some evidence for galactic expansion, which could be a consequence of mass loss. (auth)

10335 DYNAMICS AND STRUCTURE OF INERTIALLY CONFINED PLASMA CLOUDS. Christiansen, W. (Univ. of Colorado, Boulder). Mon. Notic. Roy. Astron. Soc.; 145: 327-45(1969).

Models for the evolution of inertially confined plasma clouds are developed and discussed. Providing magnetic flux is conserved, the general evolution of a plasmon does not depend on the internal equation of state of the cloud. It is shown that a plasmon can travel a distance $\sim(\rho_0/\rho_{IG})r_0$ before dispersing, where ρ_0 is the initial density of the plasma cloud, r_0 is the initial radius of the plasmon, and ρ_{IG} is the density of the intergalactic medium. Energy losses due to synchrotron radiation and the Compton effect can shorten the observable lifetime of a radio source, and this problem is discussed as it relates to observations of extended double radio galaxies. Specifically, it is concluded that in a closed universe ($\rho_{IG} \gtrsim 10^{-29}$ g cm^{-3}), the components of giant (component separation $>10^5$ pc) double radio galaxies are probably not ejected with relativistic velocities. It is also shown, using these models, that the upper limit on the observed separation between the components of double radio galaxies of $\sim 3 \times 10^5$ pc, implies an upper limit on the intergalactic matter density of $\sim 3.5 \times 10^{-29}$ g cm^{-3}. (auth)

10336 STAR FORMATION IN CLOUDS OF SOLID HYDROGEN GRAINS. II. SOME PROPERTIES OF MODEL GALAXIES. Reddish, V. C. (Royal Observatory, Edinburgh). Mon. Notic. Roy. Astron. Soc.; 145: 357-66(1969).

It has been pointed out that delay in the negative feedback in the loop "grain cooling → hydrogen freezing → star formation → grain heating" may cause overshoot in the rate of star formation. It is now shown that this will produce the observed properties of elliptical galaxies. It is also shown that the negative feedback in the evolution of a galaxy, due to the dependence of stellar mass on grain abundance, results in a high degree of uniformity among galaxies in the apparent average heavy element abundance of dwarf stars. (auth)

10337 BRIGHT END OF THE GALAXY LUMINOSITY FUNCTION IN CLUSTERS. Peebles, P. J. E. (Princeton Univ., N. J.). Nature (London); 224: 1093(13 Dec 1969).

Reference is made to the new set of values of M_1 the absolute magnitude of the first brightest member of a rich cluster of galaxies, given by Peach (Nature, 223: 1140(1969)), where it was found that the standard deviation of the new M_1 values is smaller by a factor of 2.7 than the standard deviation computed from a statistical model based in part on the older data. Peach concludes that the statistical model is inadequate and that perhaps the magnitude of the brightest cluster member is fixed independently of cluster richness or the luminosity function governing the fainter members. Some additional evidence is mentioned, however, which it is stated should be borne in mind in arriving at this or any other interpretation of the remarkable constancy of M_1. Some listed apparent properties of the bright end of the luminosity function for the great clusters are examined. A continuity and not a discontinuity at M_1 is suggested; if Peach's conclusion were adopted, two coincidences would be necessary so that both the dispersion and the mean value of M_1 show a rough continuity with an extrapolation from the fainter cluster members. It is pointed out, however, that the discussion presented depends on very limited data. It would be very useful to have data, comparable with those available for M_1, on the absolute magnitude of the second, third, etc. ranked members. Peach's consideration of the expected correlation of M_1 and cluster richness classification, is also discussed, and the analysis makes the expected variation of $\langle M_1 \rangle$ with richness smaller than Peach's estimation by a factor of ~2. It is concluded that there is still not a direct objective case for a discontinuity of properties at the first-ranked cluster member, and it seems that such an effect could be most directly established from more complete data on the luminosities of the brighter cluster members. (UK)

10338 LOCAL THEORY FOR QUASARS. Rowan-Robinson, M. (Queen Mary Coll., London). Nature (London); 224: 1094 (13 Dec 1969).

The concentration of absorption and emission redshifts of quasars around a value of 1.95, and a possible periodicity in the redshifts of quasars and other emission-line objects, have raised doubts about the cosmological origin of the redshifts. A tentative explanation is that quasars are comparatively "local" objects, although extragalactic, and that their redshifts arise mainly from some intrinsic property, such as gravitation. Provided that the redshift is independent of the distance of a source, it is possible to investigate in depth a set of sources, complete or representative, down to some limiting flux level. Such an analysis is presented; it applies even if the luminosity is a function of redshift. Even if the quasars are "local," however, they show a strong departure from uniform distribution in space, resembling the radio galaxies in this respect. A natural inference is that the number density or luminosity of these objects was greater in the past, thus ruling out the steady-state cosmology. (UK)

10339 GALACTIC X RAYS AND GAMMA RAYS. Cowsik, R.; Pal, Yash (Tata Inst. of Fundamental Research, Bombay). Phys. Rev. Lett.; 23: 1467-8(22 Dec 1969).

A consistent explanation of the observed galactic flux of high-energy γ rays and the reported galactic x-ray flux is provided in terms of Compton scattering of cosmic-ray electrons with the submillimeter radiation observed recently. It is predicted that the flux of galactic x rays, relative to that of cosmic x rays, will increase with increasing energy. Thus, if an increased enhancement in the flux of high-energy (~200-keV) x rays in going across the galactic equator is not observed, the existence, on a galactic scale, of the submillimeter radiation will be ruled out. (auth)

10340 INTERPRETATION OF THE COSMIC X-RAY BACKGROUND. Sciama, D. W. (Cambridge Univ., Eng.). Proc. Roy. Soc. (London), Ser. A; 313: 349-55(11 Nov 1969).

Recent work on the cosmic x-ray background is reviewed. The most attractive explanation of the high-energy background (>1 keV) is Compton collisions between cosmic black-body photons and relativistic electrons in radio sources of large red shift (~5). The recently discovered low-energy background (~0.25 keV) may have the same origin, or be due to emission from either a dense (about 10 atoms m^{-3}) hot (about 0.5 MK) intergalactic gas or to a more local hot gas with an emission measure ~1 cm^{-6} pc. Absorption effects are important at 0.25 keV, and significant conclusions may possibly be drawn about hydrogen, helium, carbon, and nitrogen in the intergalactic gas. The status of absorption in the Galaxy is confused. 45 references. (auth) (UK)

10341 THE SPIRAL STRUCTURE OF OUR GALAXY. II. Bok, Bart J. (Univ. of Arizona, Tucson). Sky Telesc.; 39: 21-5(Jan 1970).

This is the second part of a summary of the papers presented at the Basel symposium during the summer of 1969 on the spiral form of the Galaxy. The discussion is given in terms of the origin of the spiral pattern, radio spiral structure, optical spiral structure, and the Carina–Centaurus region. (W.D.M.)

10342 IS THE GALAXY LOSING MASS ON A TIME SCALE OF A BILLION YEARS? Sciama, D. W. (Cambridge Univ., Eng.). Nature (London); 224: 1263-7(27 Dec 1969).

It is argued that if the Galaxy has been losing mass in gravitational waves for longer than 10^9 yr at a rate recently suggested (Weber, Phys. Rev. Lett. 22: 1320(1969)), it should contain no stars in bound orbits with periods exceeding 10^9 yr. Analysis of stellar motions indicates that the distribution of periods does, in fact, show a cutoff close to 10^9 yr, although this may be for other reasons. (auth) (UK)

10343 INFALL OF GAS FROM INTERGALACTIC SPACE. Oort, J. H. (Sterrewacht, Leiden). Nature (London); 224: 1158-63(20 Dec 1969).

There are several indications that a considerable flux of gas is constantly flowing into the galactic system, and that intergalactic gas probably makes up a large fraction of the mass of the Universe. A modified version of a lecture given at the Institute of Theoretical Astronomy, Cambridge, on July 7, is presented. (auth) (UK)

10344 HIGH-RESOLUTION OBSERVATIONS OF CYGNUS A AT 2,7 AND 5 GHz. Mitton, Simon; Ryle, Martin (Mullard Radio Astronomy Observatory, Cambridge, Eng.). Mon. Notic. Roy. Astron. Soc.; 146: 221-33(1969).

Observations of Cygnus A (3C 405) were made with the One-mile telescope operating at frequencies of 2.7 and 5 GHz, where the beamwidths are 12″ × 10″ and 6.5″ × 10″ arc respectively. The maps obtained show that each component consists of a compact region of high surface brightness with an extension of decreasing brightness running towards the optical galaxy. A comparison with earlier observations shows little variation of structure with frequency except at frequencies <200 MHz; at low frequencies there is a relatively greater contribution from the extensive features, and the change in the distribution may be associated with the change in spectral index of the source in this frequency range. The observed brightness distribution of the components supports the suggestion of De Young and Axford (1967) that the plasma clouds are contained by interaction with the intergalactic medium. (auth) (UK)

10345 RATIO OF TOTAL TO SELECTIVE ABSORPTION IN THE GALAXY. Ireland, J. G.; Nandy, K. (Royal Observatory, Edinburgh). Astrophys. Space Sci.; 5: 438-43(Dec 1969).

Values for the ratio of total to selective absorption are estimated from optical measurements on Cepheids, their radial velocities, and an assumed rotational velocity model of the Galaxy. It is shown that there is no systematic variation of R with galactic longitude on the basis of these measurements. (auth)

10346 POLARIZATION TRANSFER OF ELECTROMAGNETIC WAVES IN A MAGNETIZED PLASMA. Fung, P. C. W. (Stanford Univ., Calif.). Astrophys. Space Sci.; 5: 448-58(Dec 1969).

In this investigation, the polarization transfer equations in terms of the Stokes parameters are derived for electromagnetic waves propagating in an arbitrary direction in an inhomogeneous magnetized plasma. This system of transfer equations is then solved analytically in the case when the magnetized plasma is homogeneous. For simplicity in presentation, the source term in the equation of transfer has been omitted. Transmitting to the special case of quasi-longitudinal propagation, the results obtained here are shown to be in agreement to that derived by Zheleznyakov earlier. (auth)

10347 INTERGALACTIC HYDROGEN ALONG THE PATH TO VIRGO A. Allen, R. J. (Kapteyn Astronomical Lab., Groningen, Netherlands). Astron. Astrophys.; 3: 382-7(Dec 1969).

The continuum radio spectrum of Virgo A near 21 cm wavelength (Allen, 1969) appears to be a featureless sloping line from −700 to +1800 km s^{-1}. If neutral atomic hydrogen is present in intergalactic space in quantities which are dynamically significant both for the Virgo cluster and for the deceleration of the Universe, then some evidence of its absorption effects should have been found. In the case of the Virgo cluster, the emission and absorption measurements which are currently available may be combined to give the following results: If matter is present in amounts sufficient to gravitationally stabilize the cluster, then less than 1% of it is in the form of hydrogen atoms in the ground electronic state. The absence of an absorption "trough" in the radio spectrum of Virgo A, along with Field's (1959b) theory of the excitation temperature of the intergalactic gas, yields the additional result: If the density of hydrogen gas in intergalactic space is greater than 10^{-6} atoms cm^{-3}, then it must be more than 70% ionized regardless of its kinetic temperature. These two conclusions are dependent on a simple model for the spatial distribution of neutral hydrogen in the Virgo cluster and in the space between our Galaxy and Virgo A. In particular they will not be valid if: (a) the gas is condensed into clouds, very few of which are along the line of sight, and (b) the excitation temperature equals the temperature of the cosmic microwave background, so that the gas gives no detectable radio emission. (auth)

10348 A NEUTRAL HYDROGEN STUDY OF THE INTERACTING GALAXIES NGC 4631 AND NGC 4656. Weliachew, L. (Observatoire, Meudon, France). Astron. Astrophys.; 3: 402-17(Dec 1969).

The binary system NGC 4631/NGC 4656 was investigated in the 21-cm line of neutral hydrogen with the Nançay radiotelescope. The resolution was 4′ in right ascension, 24′ in declination, and 59 km/s in velocity. Data were fitted by hydrogen distributions and velocity models by means of a computer program. The two galaxies are connected by a hydrogen link already detected elsewhere. This study shows in both galaxies important departures from circular symmetry on the sides connected with the link. The interpretation of the data, together with recent optical results, leads to a model involving a hydromagnetic interaction between the two galaxies. This interaction may result from a close approach of both galaxies. (auth)

10349 COMPANION GALAXIES ON THE ENDS OF SPIRAL ARMS. Arp, H. (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Astron. Astrophys.; 3: 418-35(Dec 1969).

Photographic and spectroscopic observations are presented which show that companion galaxies on the ends of spiral arms of normal galaxies tend to have (1) high-surface brightness, (2) emission lines characteristic of excited gaseous material, and (3) early-type stellar absorption lines in their nuclei. One companion is shown to be expanding. Another is shown to be probably receding from the center of the larger galaxy. The hypothesis advanced is that these companions have been recently ejected (10^7 to 10^8 years ago) from the parent galaxy. It is concluded that they are short-lived, and that many are now in the process of expanding and ejecting secondary material. Holmberg previously concluded that small companions were found only along the minor axis of spiral galaxies because their disks stopped ejection in the plane. The companions on the ends of spiral arms in the present paper are considered to be examples of this stopping mechanism. It is further suggested that ejection of material through the disks of rotating galaxies is generally important in the formation of spiral arms. (auth)

10350 ASPECTS OF RADIO GALAXY EVOLUTION. Van der Laan, H.; Perola, G. C. (Sterrewacht, Leiden). Astron. Astrophys.; 3: 468-76(Dec 1969).

Some aspects of radiogalaxy evolution in the light of observational evidence is considered. In the first three sections data which have a direct bearing on and provide constraints for models of radio source development are reviewed and analyzed. Modes of source evolution based on this analysis are considered. (W.D.M.)

10351 THE DISTANCES OF THE GALACTIC CLUSTERS NGC 1664 AND NGC 1605. Fang, C. (Univ., Basel). Astron. Astrophys.; 4: 75-7(Jan 1970).

The distances of the two galactic clusters NGC 1664 and NGC 1604 are determined with the method of RGU three-color photometry. The distances are found to be 1240 and 2650 pc, respectively. (auth)

10352 A COMPARISON OF THE RADIAL VELOCITIES OF THE NEUTRAL HYDROGEN GAS AND H II REGIONS WITHIN 60 DEGREES OF THE GALACTIC CENTER. Mezger, P. G. (National Radio Astronomy Observatory, Green Bank, W. Va.); Wilson, T. L.; Gardner, F. F.; Milne, D. K. Astron. Astrophys.; 4: 96-100(Jan 1970).

A comparison of the NRAO–MIT and NRAO–CSIRO–MIT H 109 α surveys and the Parkes H I 21-cm line survey shows that the kinematics of the H I gas and the H II regions agree rather well. H II regions are predominantly found in regions of high surface brightness of the 21-cm emission of the H I gas which are probably also regions of high space density. Clusters of H II regions appear to be associated with bumps in the maximum velocity curve of the H I gas. (auth)

10353 FLUCTUATIONS IN BRIGHTNESS OF THE MILKY WAY AND INTERSTELLAR CLOUDS. Peters, G. (Landessternwarte, Heidelberg). Astron. Astrophys.; 4: 134-43(Jan 970).

A statistical analysis of the fluctuations in brightness of the Milky Way is presented, using the surface photometry of Pannekoek and Koelbloed. Long-wave variations, which are produced by the large-scale star distribution, are determined and subtracted. The remaining fluctuations, due to the cloud-like structure of the interstellar extinction, are used to derive structural parameters of the interstellar dust distribution. The interpretation of the dispersion and the angular correlations of the observed intensities yields: average cloud absorption $\bar{a}_v = 0.37^m$, average cloud diameter $\bar{\Delta} = 10$ pc and optical half-thickness of the galactic dust-layer $\tau_{\frac{1}{2}v} = 0.14^m$. These results are in good agreement with determinations, based upon the color excesses of stars. The discussion of the mean square deviation of the brightness shows that the contribution of the diffuse galactic light to the observed intensity is 20 . . . 30% of the direct star light. (auth)

Cosmology

Refer also to abstract 10739.

10354 CASE OF THE MISSING MASS. Burbidge, G. R. (Univ. of California, San Diego); Sargent, W. L. W. Comments Astrophys. Space Phys.; 1: 220-5(Nov-Dec 1969).

A major problem of modern astrophysics is the question of the true mass–energy content of the universe. In this short discussion the problems associated with clusters of galaxies are surveyed. (W.D.M.)

10355 THE ASTRONOMICAL SIGNIFICANCE OF MASS LOSS BY GRAVITATIONAL RADIATION. Field, G. B. (Univ. of California, Berkeley); Rees, M. J.; Sciama, D. W. Comments Astrophys. Space Phys.; 1: 187-93(Nov-Dec 1969).

The work of Weber (1969) provides a natural starting point for this article. Weber claims to have detected a mean gravitational radiation energy density $\sim 10^{-11}$ erg cm^{-3} over a bandwidth ~ 0.017 Hz centered on a frequency of 1660 Hz. For the purposes of this article this is accepted and some of its consequences are explored. Considerations are listed which prompt the authors to air some speculations based on the hypothesis that highly efficient mass loss through gravitational radiation is a widespread phenomenon. (W.D.M.)

10356 NONEQUILIBRIUM PROCESSES IN THE EARLY UNIVERSE. Stewart, John M. (Dept. of Applied Mathematics and Theoretical Physics, Cambridge, Eng.). Mon. Notic. Roy. Astron. Soc.; 145: 347-56(1969).

In a recent paper Misner (1968) has suggested that neutrino viscosity is a highly efficient process for removing shear anisotropy during the early stages of the Universe, so that the remarkable degree of isotropy observed in the microwave background would be expected to occur whatever the initial conditions. In this paper it is suggested that the early Universe may not have been in near thermal equilibrium as Misner assumed, so that under a wide range of initial conditions, arbitrarily large anisotropy could occur at any epoch. Therefore, the observed anisotropy does place some restrictions on early conditions in the Universe. (auth)

10357 GENERATION OF MAGNETIC FIELDS IN THE PRIMORDIAL FIREBALL. Harrison, E. R. (Univ. of Massachusetts, Amherst). Nature (London); 224: 1089-90(13 Dec 1969).

It is argued that weak magnetic fields (compared with the present typical intensity of 10^{-6}G in the galactic disk) can be generated in the fireball of the early Universe. It is assumed that the Universe expands from an initial dense state, and from the 3°K background radiation and a mean material density of the order of 10^{-30} g/cm^3, it is found that there is a time when the density of radiation is greater than the density of matter. This is the radiation era of the fireball, during which era the Universe consists of a radiation-dominated plasma. Such a plasma consists of ions, electrons, and photons, but behaves as if consisting of two gases, the electrons and photons being coupled together as a single fluid. The Universe in effect consists of a positively charged ion gas and a negatively charged photon gas. It is thought that galaxies evolve from density or composition inhomogeneities already existing in the fireball, and it is assumed these inhomogeneities possess rotation. It is easily shown that rotation in an expanding radiation-dominated plasma generates a magnetic field, considering the system as a simple model of an eddy in the radiation era. The ion gas tends to spin down faster than the electron–photon gas during expansion creating an electric current that generates a magnetic field. This field is calculated, the maximum field intensity for a hydrogen plasma is found to be B = 10^{-16}G. Although the field is weak it is formed by the control of the entire material angular momentum of the galaxy and is perhaps the strangest field that can be generated in the short available time of the radiation era. Whatever method is adopted for explaining the galactic field it is presumably necessary that an initial field be generated, and that this "seed field" is then amplified and modified as the galaxy evolves. The proposed mechanism has the virture of rapidly creating perhaps the strongest of all possible large scale seed fields. (UK)

10358 TRACES OF "PHOTON EDDIES". Ozernoi, L. M. (Lebedev Inst. of Physics, Moscow). JETP Lett. (USSR) (Engl. Transl.); 10: 251-4(20 Oct 1969).

Translated from Zh. Eksp. Teor. Fiz. Pis'ma Redaktsiyu; 10: 394-8(20 Oct 1969).

According to an hypothesis advanced by Ozernoi and Chernin (1968), in the early Universe, during the phase of almost complete homogeneity, there existed local dynamic motions of the photon gas and the plasma dragged by it (photon eddies) superimposed on the general cosmological expansion. The hydrodynamics of this mixture, in conjunction with the gravitational instability, determines of necessity the subsequent structure of the Universe. It is shown that the consequences of the hypothesis, which pertain to the velocity and density spectra of metagalactic structures, are confirmed by astronomical observations. (W.D.M.)

10359 ASTROPHYSICS AND STELLAR ASTRONOMY. Swihart, Thomas L. Space Science Text Series. New York; John Wiley and Sons, Inc. (1968). 307p. $9.95.

The Introduction develops selected topics of physics that are of special importance to astronomy and that are used considerably in later parts of the book. The first two chapters (Positions and Magnitudes of the Stars; Binary and Variable Stars) cover the "service" areas of astronomy, i.e., areas whose main importance lies in the gathering of data from other areas. The last two chapters (Astrophysics; Galaxies and Cosmology) form the main part of the book, the preceding material being only introductory. (W.D.M.)

Planetary Phenomena

10360 (AD-695398) ALPHA PARTICLE EMISSIVITY OF THE MOON: AN OBSERVED UPPER LIMIT. Yeh, Richard S.; Van Allen, James A. (Iowa Univ., Iowa City. Dept. of Physics and Astronomy). Jul 1969. 26p. CFSTI.

From observations with the moon-orbiting spacecraft Explorer 35 during 1967–1968, it is unlikely that the alpha particle emissivity of the Moon is greater than 0.064/cm^2 sr^{-1} and exceedingly unlikely that it is greater than 0.128, these values being respectively 0.1 and 0.2 of provisional estimates by Kraner et al. in 1966. This result implies that the abundance of ^{238}U in the outer crust (nearly equal to a few meters in thickness) of the Moon is very much less than that typical of the Earth's lithosphere, though it is consistent with the abundance of ^{238}U in terrestrial basalt or in chondritic meteorites. (auth) (USGRDR)

10361 THE IONOSPHERES OF VENUS AND MARS. I. MARINER IV AND PRELIMINARY IDEAS. Goody, Richard (Harvard Univ., Cambridge, Mass.). Comments Astrophys. Space Phys.; 1: 194-7(Nov-Dec 1969).

The Mariner-IV Mars flyby in July 1965 yielded a profile of electron density as a function of height, and Mariner V in October 1967 gave both daytime and nighttime profiles for Venus. These data have led to a major reorientation of the ideas about ionospheric physics, and some of these developments are reviewed in a historical perspective. (W.D.M.)

10362 CIRCULAR POLARISATION OF JUPITER AT 9.26 cm. Seaquist, E. R. (Univ. of Toronto). Nature (London); 224: 1011-12(6 Dec 1969).

Radio signals from Jupiter have a small but detectable circular polarization whose value is correlated with system III longitude of the central meridian (LCM), and previous measurements of this quantity are briefly reviewed. The observations now reported were made at 9.26 cm (3,240 MHz) with the 46-m telescope of the Algonquin Radio Observatory during April and July 1969, and the experimental technique is described. Results are shown plotted against LCM; there is clearly a sinusoidal variation. The results disagree with those of Berge (Astrophys. J., 142: 1688(1965)) in regard to both amplitude and phase. The results may be used to provide information concerning the magnetic field of Jupiter, leading to the conclusion that there are magnetic fields in the radiating regions with B $\gtrsim$ 0.04G. The longitude of the north magnetic pole of Jupiter may also be inferred. It is to be noted that if the Jovian radiation belts can be described in terms of an electron distribution which is symmetric about the equator of a magnetic dipole, then the mean circular polarization over the period of rotation will be an antisymmetric function of the Jovicentric declination of the Earth. (UK)

Atomic and Molecular Physics

Atomic, Electron, Ion, and Molecular Beams and Their Reactions

Refer also to abstract 10053.

10363 (UCRL-50754) CROSS-BEAM NEUTRALIZER FOR A 2 keV PROTON BEAM. Goodman, Ronald K. (California Univ., Livermore. Lawrence Radiation Lab.). 22 Sep 1969. Contract W-7405-eng-48. 10p. Dep. CFSTI.

Experimental results indicate that a cross-beam water vapor neutralizer, designed for use with 1- to 15-keV proton beams,

may significantly lower the amount of thermal gas that effuses down the beam-line. Effused gas may be reduced by as much as a factor of 7, when compared with a conventional gas-cell neutralizer. A description of the neutralizer and experimental measurements is given. (auth)

10364 ROLE OF THE REVERSE CURRENT IN THE INTERACTION OF IONS WITH SOLIDS. Abroyan, I. A.; Eremeev, M. A.; Tsekhnovicher, L. A. (Leningrad Polytechnic Inst.). Sov. Phys.-Solid State (Engl. Transl.); 11: 1276-80(Dec 1969). Translated from Fiz. Tverd. Tela; 11: 1575-81(Jun 1969).

The ion–electron emission, scattering of primary particles, and radiation conductivity were investigated during bombardment of Ge single crystals by hydrogen ions H_1^+, H_2^+, and H_3^+ and helium ions He^+ having energies of several thousand electron volts. The number of secondary electrons emitted into the vacuum, the number of electron-hole pairs excited in the semiconductor, and the number and energy of the back-scattered primary particles depends on the orientation of the bombarding beam relative to the crystallographic axes. It was established that reflection takes place almost exclusively in the form of neutral particles and depends only weakly on the initial energy of the primary ions and the temperature of the crystal. The observed dependence of the reflection on the type of bombarding ion allows one to conclude that the atoms in a molecular ion are not independent during scattering. A comparison is made of the amounts of energy carried away from the crystal by reflected particles during bombardment by ions and electrons. The reason for the nonmonotonic angular dependence of the radiation conductivity was analyzed. A quantitative treatment of the contribution of reflected particles to the ion–electron emission is given. It is found that in germanium under certain conditions, helium ions can excite more nonequilibrium carriers than electrons with the same initial energy. (auth)

10365 DOPPLER SHIFT FOR ATOM SCATTERING BY SOLIDS. Parilis, E. S. (Inst. of Electronics, Tashkent). Sov. Phys.-Solid State (Engl. Transl.); 11: 1270-2(Dec 1969). Translated from Fiz. Tverd. Tela; 11: 1569-71(Jun 1969).

The radiation spectrum of fast ions excited by collision with the surface of a solid contains discrete lines whose form and position is determined by the Doppler frequency shift, which, in turn, is due to the motion of the radiating atoms after scattering. Here, light of a given frequency is radiated by atoms moving along the surface of a cone having a form determined by the angular distribution and energy distribution of the scattered particles, the angular dependence of the ion excitation probability, and the nature of ion neutralization near the metal surface. Part of the light incident on a spectrometer is the result of reflection of this radiation from the surface of the metal, and its frequency is correspondingly shifted. Equations and calculational results are given for the form of the spectral line of 20-keV argon ions scattered by copper. The chief contribution to the spectral-line intensity is provided by ions scattered along the surface of the metal. The greater the probability of charge exchange, which depends upon the orientation of the reflected beam relative to the direction of face-centered packing, the greater the degree of radiation anisotropy when ions are scattered by the face of the single crystal. (auth)

10366 THRESHOLD REACTIONS FOR THE FORMATION OF ION–DIPOLE PAIRS AS A METHOD FOR OBTAINING MONOENERGETIC POLARIZED MOLECULAR BEAMS. Baz, A. I.; Gol'danskii, V. I. (Inst. of Chemical Physics, Moscow). J. Chem. Phys.; 51: 5401-4(15 Dec 1969).

The energy dependence of the cross sections of an endothermal reaction a + b → I + D (I, ion; D, dipole; e.g., $Na^+ + Cl_2 \rightarrow Cl^+ + NaCl$) near its threshold is analyzed. When the product dipolar molecule leaves the reaction center so that the end having the same charge as that of the ion I (Na in our example) is leading, the cross section σ_1 for the reaction increases rapidly from the threshold and soon attains the geometrical value. When the end having a charge opposite to that of I (Cl in our example) is leading, the cross section (σ_2) increases but slowly, remaining much smaller than σ_1 over an energy range of several electron volts. Therefore the reaction a + b → I + D in this region near the threshold can be used for obtaining monoenergetic beams of polarized dipole molecules D. The effect of the threshold of the above-mentioned reaction on excitation functions of other processes like a + b → c + d (including the a–b elastic scattering) is also treated. (auth)

10367 NONINVARIANCE OF THE NOISE PARAMETERS S AND P IN ELECTRON FLUXES WITH VARIABLE CROSS SECTIONS. Golubentsev, A. F. (Saratov State Univ., USSR). Zh. Tekh. Fiz.; 39: 1859-62(Oct 1969). (In Russian).

The noninvariance of noise parameters S and P in a one-velocity region of variable cross section electron flux was established. The noninvariant S and P in the one-velocity region results in considerable reduction of the maximum noise coefficient when used for converging beams. The new results are based on the previously reported data on the theory of space charge waves in variable cross section electron beams (Kulakov, Zh. Tekh. Fiz., 37: 650(1967)). (tr-auth)

10368 THE INTERACTION OF ATOMIC PARTICLES WITH SOLID SURFACES AT INTERMEDIATE ENERGIES. II. SCATTERING PROCESSES. Cawthron, E. R.; Cotterell, D. L.; Oliphant, Mark (Australian National Univ., Canberra). Proc. Roy. Soc. (London), Ser. A; 314: 53-72(16 Dec 1969).

Measurements were made of the energy distributions of charged particles emitted from targets of platinum, nickel, and molybdenum bombarded by atomic and molecular positive ions of hydrogen, deuterium, helium, carbon, nitrogen, oxygen, neon, argon, and carbon dioxide, with energy 2 to 40 keV. It is shown that the scattering of incident particles is predominantly elastic and approximately independent of the charge state of the incident particle. Hydrogen, deuterium, carbon, and oxygen are scattered with both positive and negative charges, but CO_2 gives only negatively charged scattered particles. Scattering with positive charge increases over an energy range 2 to 15 keV per incident particle, while scattering with negative charge increases to a maximum at incident energies 3 to 7 keV per particle and then decreases up to the highest energies used, 40 keV. Scattering with positive and negative charges is of the same magnitude at the incident energy corresponding with the maximum for negative scattering of hydrogen ions. The energy distribution of negatively charged scattered ions is generally broader than that for positively charged scattered ions at the same incident energy, for the lighter ions. Scattering as neutral atoms is estimated roughly and is shown to increase rapidly as the bombarding energy is reduced below about 10 keV. (auth) (UK)

10369 THE INTERACTION OF ATOMIC PARTICLES WITH SOLID SURFACES AT INTERMEDIATE ENERGIES. I. SECONDARY ELECTRON EMISSION. Cawthron, E. R.; Cotterell, D. L.; Oliphant, Mark (Australian National Univ., Canberra). Proc. Roy. Soc. (London), Ser. A; 314: 39-51(16 Dec 1969).

The electron emission from a number of metal and carbon targets bombarded by various positive ions is measured by a method employing a magnetic field to separate secondary electrons from scattered ions. Molecular ions are shown to produce emission approximately equal to that which would be produced by the individual atoms independently. Accurate measurements have been made of the energy distribution of secondary electrons. These are close to Gaussian. It is concluded that secondary electron emission is confined to the surface layers of the target atoms since no electrons possess energies close to zero. (auth) (UK)

Atomic and Molecular Properties

Refer also to abstracts 10242, 10329, 10516, and 10549.

10370 MIXING OF HYDROGEN ATOM LEVELS DUE TO HYPERFINE INTERACTION. Ivanov, A. S. (Joint Inst. for Nuclear Research, Dubna, USSR). Zh. Eksp. Teor. Fiz.; 57: 1601-4(Nov 1969). (In Russian).

Mixing of hydrogen-atom levels due to interaction with the magnetic field produced by the proton spin is considered. Not only the case $\Delta l = 0$ but also the case $\Delta l = 2$ is analyzed. Variation of the atomic magnetic moment and removal of forbiddenness for certain optical transitions are discussed. (auth)

10371 DOUBLE CONFIGURATION SELF-CONSISTENT FIELD STUDY OF THE $^1\Pi_u$, $^3\Pi_u$, $^1\Pi_g$, AND $^3\Pi_g$ STATES OF H_2. Zemke, Warren T. (Illinois Inst. of Tech., Chicago); Lykos, Peter G.; Wahl, Arnold C. J. Chem. Phys.; 51: 5635-50(15 Dec 1969).

Complete potential-energy curves for the four lowest-lying Π states of the hydrogen molecule are calculated using an hierarchy of one- and two-configuration model wave functions: the Hartree–Fock model, the configuration interaction model, and the optimal double configuration model (a double configuration SCF model). Comparison and evaluation of the three models are given as a function of internuclear separation of the nuclei for the $^1\Pi_u$ state. An extended basis set of 10 Slater-type orbitals on each nucleus is scaled optimally for the $^1\Pi_u$ state; the spectroscopic constants for this state are in excellent agreement with experiment. The basis set used for the $^1\Pi_u$ state is employed in determining the potential-energy curves for the $^3\Pi_u$, $^1\Pi_g$, and $^3\Pi_g$ states; the $^3\Pi_u$ state shows good agreement with experiment, and the essential features for the Π_g states are characterized properly. (auth)

10372 HARTREE–FOCK APPROXIMATION TO THE $(ns^2)^1S$ AUTOIONIZING STATES OF HELIUM. Ramaker, D. E. (Univ. of Iowa, Iowa City); Stevenson, R. B.; Schrader, David M. J. Chem. Phys.; 51: 5276-83(15 Dec 1969).

As a first step in estimating the utility of the Hartree–Fock method for calculating positions and widths of autoionizing levels

of atoms and molecules, an investigation of the helium problem has been initiated and is reported here. Wave functions and energies for the ten lowest $(ns^2)^1S$ states are calculated by numerically integrating the Hartree–Fock equation for solutions corresponding to energy levels above the ground state. Except for n = 1 all these states are autoionizing, and each is probably the lowest bound state for each closed channel for n = 2(1)10. The energies of the ns^2 states are found to be between the nth and (n−1)th thresholds for n = 2(1)6 but for n > 6 the calculated levels fall below the (n−1)th threshold. The method of numerical integration used is described, and the wave functions are reported in terms of an expansion in a basis determined by a least-squares curve-fitting method. (auth)

10373 TEST OF THE POLARIZED ORBITAL METHOD: H^-. Oberoi, R. S.; Callaway, J. (Louisiana State Univ., Baton Rouge). Phys. Rev., A; 1: 45-52(Jan 1970).

The polarized-orbital method and many of the common variations and approximations of this approach are tested in a computation of the binding energy of the negative hydrogen ion H^-. It is found that if a trial wave function for H^- is constructed from a distorted atomic wave function in which the first-order perturbed orbital is simply added to the undistorted atomic function, the result is a very poor approximation (binding energy −0.0094 Ry). However, if the trial function is modified, as suggested by Drachman, with the introduction of an additional independent function multiplying the perturbed orbital, the result is quite good, the binding energy being −0.0544 Ry. For comparison, the exact value (due to Pekeris) is −0.0555 Ry. (auth)

10374 DETERMINATION OF THE Li^+–He INTERACTION POTENTIAL FROM LOW-ENERGY EXPERIMENTAL DIFFERENTIAL SCATTERING CROSS SECTIONS. Olson, R. C. (Stanford Research Inst., Menlo Park, Calif.); Smith, F. T.; Mueller, C. R. Phys. Rev., A; 1: 27-30(Jan 1970).

The Li^+–He experimental elastic differential cross sections of Aberth and Lorents in the 3.6- to 218-eV energy range were analyzed and yielded a simple repulsive potential. The potential may be parametrized as $V(R) = 2.95 \times 10^2 \exp(-4.30\ R) + 1.00 \times 10^3 \exp(-20.4\ R)$ in which R is in Å, and the energy is in eV. The estimated error is ±25% for 0.30 Å < R < 0.80 Å. The potential is in fair agreement with recent ab initio quantum calculations and the potential of Zehr and Berry who analyzed the energy loss of Li^+ as a function of scattering path length. (auth)

10375 ACCURATE ANALYTICAL SELF-CONSISTENT-FIELD WAVE FUNCTIONS FOR Nd^{3+}. Synek, M.; Grossgut, P. (Texas Christian Univ., Fort Worth). Phys. Rev., A; 1: 1-3 (Jan 1970).

Self-consistent-field wave functions were calculated by the analytical-expansion method for the ground state of the laser-active ion Nd^{3+} (Z = 60), $4f^3$, ^4I. The results represent the most accurate wave functions for Nd^{3+} published. All the exponents of the basis functions in the analytical expansion were exhaustively optimized. The virial theorem was satisfied to seven significant figures. Values of $\langle r^{2l} \rangle$ for the 4f orbital are included. (auth)

10376 THE SMALL κ METHOD OF NEUTRON MOLECULAR SPECTROSCOPY. Brugger, R. M.; Strong, K. A.; Grant, D. M. (Idaho Nuclear Corp., Idaho Falls). pp 323-9 of Neutron Inelastic Scattering. Vol. II. Vienna; International Atomic Energy Agency (1968).

From Symposium on Inelastic Neutron Scattering, Copenhagen, Denmark. See STI/PUB-187(Vol.2); CONF-680501(Vol.2).

In slow neutron inelastic scattering experiments at the MTR, it has been shown that discrete peaks can be observed in the neutron inelastic scattering spectra by observing the spectra at small momentum changes $\hbar\kappa$. Similar peaks are not observed in data at higher momentum changes because the widths of the elastic and inelastic peaks which are proportional to $\sqrt{\kappa^2 T/M}$ are large enough to overlap. Here T is the absolute temperature and M is the effective mass. Lowering T and increasing M narrows the peaks to some extent, but often the former change induces a phase change in the sample under study. The most effective way to narrow the peaks so that they do not overlap and can be observed as discrete peaks is to make κ small. In the MTR experiments, this is achieved by observing the scattering at smaller angles and with incident neutrons of a higher energy. Because the inelastic scattering intensity is small compared to the elastic scattering, much care must be given to suppressing the background, multiple scattering, and air scattering. Data showing the transitions between librational levels in liquid neopentane demonstrate the effectiveness of the small-κ method of neutron molecular spectroscopy. (auth)

10377 K-SHELL PHOTOELECTRIC CROSS SECTIONS. Rao, B. V. Narashimha; Parthasaradhi, K. (Andhra Univ., Waltair, India). J. Appl. Phys.; 40: 5391-2(Dec 1969).

K-shell photoelectric cross sections were derived for Cu, Mo, Ag, Sn, W, Au, Pb, and U by subtracting coherent and incoherent scattering cross sections from the experimental total gamma-ray cross sections at energies above the K edge, and dividing the result by the experimental total/K-shell cross section ratio. These values are plotted vs energy along with the theoretical values of Schmickley and Pratt (Phys. Rev. 164, 104(1967)); excellent agreement is found with a general deviation of 1 to 2%, except for a deviation of >5% for U near the K edge. (D.L.C.)

10378 VISIBLE SPECTRUM OF THE La_2 MOLECULE. Carette, Pierre; Blondeau, Jean-Marie (Laboratoire de Spectorscopie Optique, Annappes, France). Compt. Rend., Ser. B, 269: 16-18(July 7, 1969). (In French).

In the region extending from 6040 to 6100 Å, a band spectrum emitted by lanthanum vapor at 2000°C in a furnace was observed. This spectrum, formed by two systems of the tops of very compact bands, allows the vibration constants of the La_2 molecule to be calculated. The study is of interest in astrophysics because of the presence of lanthanum in certain S-type stars. (J.F.P.)

Positronium, Muonium, and Mesic Atoms and Molecules

Refer also to abstract 10637.

10379 DIRECT MEASUREMENT OF THE TRANSFER RATES OF MUONS FROM μp MUONIC ATOMS TO ARGON, KRYPTON, AND XENON ATOMS. Placci, A. (CERN, Geneva); Zavattini, E.; Bertin, A.; Vitale, A. Nuovo Cim.; 64A: 1053-67(21 Dec 1969).

The rates of the muon transfer reaction $\mu p + {}_zY \rightarrow \mu\ {}_zY + p$ were measured in a target of ultrapure gaseous hydrogen at 10 atmospheres contaminated by a small proportion of the ${}_zY$ element (${}_zY$ stands here for argon, krypton, and xenon). The results are compared with preceding experimental data and discussed in connection with those obtained for the reaction $\mu d + {}_zY \rightarrow \mu\ {}_zY + d$. (auth)

Collision Phenomena

Refer also to abstracts 9347, 9704, and 10881.

10380 EXCITATION OF K^+, Rb^+ AND Cs^+ IONS IN SLOW COLLISIONS WITH INERT GAS ATOMS. Matveev, V. B.; Bobashev, S. V.; Dukelskii, V. M. (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Eksp. Teor. Fiz.; 57: 1534-42(Nov 1969). (In Russian).

The excitation functions of resonance lines of K^+, Rb^+, and Cs^+ ions induced by collisions with inert gas atoms are studied at energies from 12 keV down to the threshold. Some resonance lines emitted by the target atoms are also investigated. The thresholds for the indicated resonance lines produced in collisions of K^+ with He, Ne, Ar, Kr, Xe, Rb^+ with He, and Cs^+ with He and Ne are determined. An analysis shows that the experimental thresholds correspond to the ordinates of the pseudocrossings of the excited levels of the system with its normal level. The values of the potential curve pseudocrossing abscissas are estimated. In the simplest cases the shapes of the excitation functions can satisfactorily be described by the Landau–Zener theory in the two-term approximation. The discrepancy between this dependence and that observed in the experiments in a number of cases can be accounted for by the effect of other inelastic processes. In the case of three terms the relation between the cross sections for various scattering channels is illustrated by the behavior of the Ne I resonance line excitation functions in the vicinity of the threshold for excitation of K II resonance levels during collisions between K^+ and Ne atoms. (auth)

10381 CLASSICAL APPROXIMATION IN THE THEORY OF INELASTIC COLLISIONS BETWEEN HIGHLY EXCITED ATOMS AND CHARGED PARTICLES. Beigman, I. L.; Vainshtein, L. A.; Sobelman, I. I. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz.; 57: 1703-9(Nov 1969). (In Russian).

The problem of calculating the effective cross sections for inelastic collisions between highly excited atoms and electrons in the quasiclassical approximation can be reduced to determination of the action function increment in the collisions, i.e., to integration of the classical Hamilton–Jacobi equation. This approach removes the well known difficulties connected with the determination of the cross section by the classical method and permits one to obtain the cross sections as a limiting case that is an alternative of perturbation theory. An interpolation formula is proposed for the general case. The nature of the approximation is illustrated in the case of the dipole approximation. (auth)

10382 SPECTRUM OF FAST ELECTRONS PRODUCED IN COLLISIONS BETWEEN PROTONS AND HEAVY ATOMS. Palkina, L. A.; Smirnov, B. M. (Moscow Energetics Inst.). Zh. Eksp. Teor. Fiz.; 57: 1728-9(Nov 1969). (In Russian).

The spectrum of electrons emitted from heavy atoms as a result of proton impact is calculated. The number of electrons expelled with an energy ϵ varies as $d\epsilon/\epsilon^5$. (auth)

10383 EXTRACTION OF REACTION CROSS SECTION FROM RATE CONSTANT DATA: D + H_2 → HD + H. Melton, L. A.; Gordon, R. G. (Harvard Univ., Cambridge, Mass.). J. Chem. Phys.; 51: 5449-57(15 Dec 1969).

Assuming a Boltzmann distribution of reactant velocities, rigorous and optimal bounds to the reaction cross section for the reaction D + H_2 → HD + H have been calculated from rate data. Neither thermal rate constant data nor rate constant data for reactions of monoenergetic D atoms with thermal H_2 determine the reaction cross section. An upper bound to the threshold energy of 0.28 eV has been obtained from the thermal rate constant data. Methods based upon Tschebychev analysis have been developed to test the internal consistency of a set of data points. (auth)

10384 SEMICLASSICAL TRANSITION PROBABILITIES FOR COLLINEAR COLLISIONS BETWEEN AN ATOM AND A MORSE OSCILLATOR. Locker, David J.; Endres, Paul F. (Univ. of Rochester, N. Y.). J. Chem. Phys.; 51: 5482-6(15 Dec 1969).

The N-state semiclassical approach is used in the calculation of vibrational transition probabilities for atom–Morse-oscillator collinear collisions. Exact semiclassical calculations for several initial classical phases are compared with rigid-body results. The transition probabilities are found to be strongly dependent upon the initial phase. Two procedures are used for matching the Morse potential to a quadratic potential. The resulting transition probabilities indicate that the potentials should be matched on their repulsive sides rather than at their minima. (auth)

10385 ENERGY TRANSFER IN CLASSICAL Br_2–Ar COLLISIONS. Razner, Ronald (Lewis Research Center, Cleveland). J. Chem. Phys.; 51: 5602-9(15 Dec 1969).

Computer calculations of three-dimensional classical trajectories for Br_2–Ar collisions indicate that vibration–rotation coupling in the Br_2 molecule can play a significant role in energy transfer. For Br_2 molecules with specified initial internal energies embedded in a heat bath of Ar at 1800°K, probability distributions for internal energy changes and angular momentum transfers were determined. These indicate the possibility of attaining classical Br_2 angular momenta large enough so that "vibrational energy" and "rotational energy" for the free molecule are not separable, and that collisions with large angular momentum changes may be responsible for a large part of the overall Br_2–Ar energy transfer. Amplitudes of vibration–rotation coupling are presented for Br_2 energies of 0.1 D_e, 0.5 D_e, and 0.9 D_e, through a range of angular momentum found to be pertinent to the problem. Possible implications of the results for Br_2–Ar energy transfer in shock-tube studies are discussed. (auth)

10386 ATOMIC AND MOLECULAR PHOTOELECTRON ANGULAR DISTRIBUTIONS MEASURED NEAR THRESHOLD. McGowan, J. William; Vroom, D. A.; Comeaux, A. R. (Gulf General Atomic Inc., San Diego, Calif.). Contract AT(04-3)-167. J. Chem. Phys.; 51: 5626-34(15 Dec 1969).

The differential angular distributions of photoelectrons emitted in the formation of various ionic states have been determined for Ar, Kr, Xe, H_2, N_2, and O_2. Where possible several photon energies have been employed, the 21.21-eV He resonance line and the 16.67- and 16.85-eV Ne resonance doublet. In most cases the angular dependence for the photoelectron emission can be described by a function of the form $1 + \beta P_2 (\cos \Theta)$. For certain of the rare gases ionized by the Ne resonance doublet large deviations from this prediction were obtained. These deviations are related to the energy of the outgoing electron and the structure of the ionic species formed. (auth)

10387 PERMEABILITY FOR THE REACTION H + H_2 = H_2 + H TREATED AS A LINEAR ENCOUNTER USING VARIATIONAL TECHNIQUES. Mortensen, Earl M.; Gucwa, Lois D. (Univ. of Massachusetts, Amherst). J. Chem. Phys.; 51: 5695-5702 (15 Dec 1969).

Variational calculations for determining the permeability of the Sato potential-energy surface as described by Weston have been made for the reaction H + H_2 = H_2 + H treated as a linear encounter. The results compare favorably with the corresponding calculations of Mortensen and Pitzer. The variational functions describing the asymptotic regions have a form after that of Kohn. (auth)

10388 THEORY OF REACTIVE SCATTERING. I. HOMOGENEOUS INTEGRAL SOLUTION FORMALISM FOR THE REARRANGEMENT τ-OPERATOR INTEGRAL EQUATION. Kouri, Donald J. (Univ. of Houston, Tex.). J. Chem. Phys.; 51: 5204-15(15 Dec 1969).

The integral equation for the rearrangement τ operator is used as the basis for a discussion of reactive scattering. The concept of the amplitude density introduced by Johnson and Secrest is extended to reactive collisions by means of the τ operator. The homogeneous integral solution method of Sams and Kouri is used to develop a noniterative solution to the integral equation satisfied by the reactive-scattering amplitude density. This method is characterized by very stable behavior and is capable of quite accurate solutions with a relatively large step size. The formulation of the method is considered first for a general reactive collision. Both open- and closed-channel contributions to the reactive scattering amplitude density are considered. The Feshbach projection operator formalism is employed to treat the effects of complex formation due to virtual excitation of internal degrees of freedom. After the general reactive collision is discussed the specific problem of atom–diatom reactions is dealt with. Notation and techniques developed by Miller are used to treat problems associated with coordinates. Unlike Miller's discussion of reactive scattering, the present approach does not require inclusion of square integrable functions since the integral equation for the τ operator (and the equation for the amplitude density) already takes explicit account of the effects described by such terms. Further, the present approach allows one to study easily the effects of vibrational and/or rotational excitation on the reaction rate since the initial state appears explicitly as an inhomogeneity in the integral equation for the reactive scattering amplitude density. Finally, the manner in which the T matrix may be obtained from the reactive scattering amplitude density is discussed. It results that the reactive T matrix may be expressed in terms of the nonreactive T matrix. (auth)

10389 DIFFERENTIAL CROSS SECTIONS FOR THE ELECTRON-IMPACT EXCITATION OF VIBRATIONAL LEVELS IN MOLECULES. Bonham, R. A. (Indiana Univ., Bloomington. Faculte des Sciences, Orsay, France); Geiger, J. J. Chem. Phys.; 51: 5246-54(15 Dec 1969).

The angular dependence of scattered electrons that have excited a particular vibrational level of the ground electronic state of a molecule is investigated. General expressions are developed for the differential electron-scattering cross sections for the excitation of vibrational levels in terms of derivatives of the ground-state electron density and derivatives of the total electric dipole and quadrupole moments. Results for the small-angle limit are obtained, and the errors in the theory and their possible effect on the small-angle scattering are discussed. It is shown that contributions to the scattering from overtone and combination frequencies increase in comparison to contributions from the infrared allowed fundamental transitions with increasing scattering angle. The relationship between the electronic contribution to the large-angle scattering and certain vibrational corrections to the vibrationally averaged three-dimensional molecular electron density is pointed out. (auth)

10390 NONREACTIVE INELASTIC SCATTERING PROCESSES IN LOW ENERGY Ar^+–D_2 COLLISONS. Moran, T. F.; Cosby, P. C. (Georgia Inst. of Tech., Atlanta). J. Chem. Phys.; 51: 5724-5(15 Dec 1969).

Processes of the type $Ar^+ (^2P_{\frac{3}{2}}) + D_2(v = 0) \rightarrow Ar^+ (^2P_{\frac{3}{2}}) + D_2(v = v')$ and $Ar^+(^2P_{\frac{1}{2}}) + D_2(v = 0) \rightarrow Ar^+ (^2P_{\frac{3}{2}}) + D_2(v = v')$, where $v' = 0, 1, 2$, which result in discrete energy losses of the reactant Ar^+ beam, were studied. A typical energy distribution of scattered Ar^+ ions is shown. Relative transition probabilities for both ion beam and target are given. These transition probabilities are approximately constant with reactant ion energy with a total cross section of order 0.5 $Å^2$. (A.G.W.)

10391 ION–ION MUTUAL NEUTRALIZATION CROSS SECTIONS MEASURED BY A SUPERIMPOSED BEAM TECHNIQUE. Aberth, William H.; Peterson, James R. (Stanford Research Inst., Menlo Park, Calif.). Phys. Rev., A; 1: 158-65(Jan 1970).

Ion–ion neutralization cross sections have been measured for $N^+ + O^-$, $N_2^+ + O_2^-$, and $O_2^+ + O_2^-$. The kinetic energy range, in the barycentric coordinate system covered by the experiment, is between 0.1 and 98 eV with an energy resolution of about 0.1 eV. The products of the neutralization cross section Q times the relative speed v_r are nearly independent of energy, having values close to 10^{-7} cm^3/sec for all three systems studied, except that below 0.5 eV the $N^+ + O^-$ and $N_2^+ + O_2^-$ systems show a rapid increase of Qv_r with decreasing energy. The experiment employs the superposition of positive- and negative-ion beams of several

keV energy over a common path length of 33 cm. The beams are subsequently separated and the neutral products of the reaction are measured. (auth)

10392 COLLISIONALLY INDUCED PHOTOABSORPTION BY THE H^- ION. Watson, William D. (Massachusetts Inst. of Tech., Cambridge). Phys. Rev., A; 1: 4-6(Jan 1970).

The influence of charged-particle interactions on the photoionization cross section of H^- is reinvestigated. In particular, polarization of the initial state, which gives rise to a free s-wave electron in the final state, is considered. It is found that a perturber density of roughly 10^{20} cm^{-3} is necessary in order for this process to compete with the usual transition in the near-infrared region. This is in sharp disagreement with the result of a previous investigation. (auth)

10393 PRODUCTION OF H ATOMS IN THE 3s STATE BY THE IMPACT OF FAST GROUND-STATE H ATOMS ON N_2. Hughes, R. H.; Filippelli, A. R.; Petefish, H. M. (Univ. of Arkansas, Fayetteville). Phys. Rev., A; 1: 21-3(Jan 1970).

Cross sections for the production of hydrogen atoms in the 3s state by the impact of ground-state hydrogen atoms on nitrogen molecules were measured in the kinetic energy range 10 to 35 keV. The cross-section curve appears to have a maximum at the lower energies of about 4×10^{-18} cm^2. This value is roughly $2\frac{1}{2}$ times less than the maximum cross section for producing 3s atoms through electron capture by proton impact on nitrogen molecules in the same energy range. (auth)

10394 PLURAL AND MULTIPLE SCATTERING OF FAST ELECTRONS IN GASES. Center, R. E. (Avco Everett Research Lab., Everett, Mass.). Phys. Fluids; 13: 79-88(Jan 1970).

The scattering of fast electrons in nitrogen and argon was investigated under conditions resulting in approximately 1 to 100 small-angle scattering collisions. Experimental measurements were made of the spatial distribution of the scattered electrons for highly collimated incident electron beams. Electron energies of 20, 40, and 100 keV and gas target thickness of 3 to 1000 torr cm at room temperature were used. The experimental distributions are much wider than predicted for single scattering and were approximately Gaussian for thick targets with many electron collisions. The dependence of the measured half-current beamwidth on the target thickness varied from a $^3/_2$ power law at small target thicknesses to a $^1/_2$ power law in thick targets. Direct analog Monte Carlo calculations were made based on a screened cross section including the large contribution by inelastic collisions at very small scattering angles. Despite the approximate nature of the cross-section data the calculated spatial distributions of scattered electrons agree well with the experimental results except at the smallest target thicknesses where the calculated distributions are wider than the experimental results. (auth)

10395 ELECTRO-CAPTURE CROSS-SECTIONS IN VARIOUS GASES BY PROTONS WITH ENERGIES FROM 25 TO 38 MeV. Acerbi, E.; Candoni, B.; Castiglioni, M.; Dutto, G.; Fait, G.; Resmini, F.; Succi, C. (Univ., Milan. Istituto Nazionale di Fisica Nucleare, Milan). Nuovo Cim.; 64A: 1068-81(21 Dec 1969).

Measurements of electron-capture cross sections by fast protons in N_2, O_2, and Ar were made in the energy range from 25 to 38 MeV, by using the variable-energy proton beam of the Milan cyclotron. The cross-section values were determined with an overall accuracy of ±12%. The results obtained, which extend to higher energies the range of the previous experimental data, are compared with published theoretical estimates, and a practical formula for the calculation of the cross-sections at high energies is proposed. (auth)

Atomic Theory

10396 RELATIVISTIC STUDY OF $L_1L_2M_{4,5}$ COSTER-KRONIG TRANSITIONS. Talukdar, Benoy (Visva-Bharati Univ., Santiniketan, India); Chattarji, Dipankar. Phys. Rev., A; 1: 33-6(Jan 1970).

A relativistic expression for $L_1L_2M_{4,5}$ Coster–Kronig transition probabilities has been obtained by using the solutions of the Biedenharn symmetric Dirac–Coulomb Hamiltonian. The interaction matrix element yields the well-known nonrelativistic result in the appropriate limit. Numerical results for atoms having Z values between 32 and 41 are compared with earlier calculations. Relativistic effects are shown to be sufficiently pronounced as not to be critically affected by the choice of a screening parameter The transition probability at the cutoff point is appreciably greater than earlier nonrelativistic values. (auth)

10397 LONG-TERM SOLUTIONS IN SEMICLASSICAL RADIATION THEORY. Stroud, C. R. Jr. (Univ. of Rochester, N. Y.); Jaynes, E. T. Phys. Rev., A; 1: 106-21(Jan 1970).

An improved form of semiclassical radiation theory is developed, which includes the effect of the atom's radiation field back on the atom. This formalism is applied to the problem of a single "two-level atom" interacting with a monochromatic field. The resulting equations are solved without resorting to time-dependent perturbation theory, and are found to predict the behavior of the system over times long compared with the lifetime for spontaneous transitions. Not only stimulated emission and absorption, but also spontaneous emission with the proper Einstein A coefficient, and a frequency shift that agrees at least semiquantitatively with the Lamb shift are described. In addition, several nonlinear effects involving the interference between spontaneous and stimulated radiation are described, and new experiments that might detect such effects are suggested. (auth)

10398 CONDITIONS ON THE EXPANSION COEFFICIENTS OF THE REDUCED TWO-PARTICLE DENSITY MATRIX. Kijewski, Louis J. (Monmouth Coll., West Long Branch, N. J.). Phys. Rev., A; 1: 217-19(Jan 1970).

An explicit reduction in the number of terms of the expansion of the reduced two-particle density matrix for atomic systems is shown to occur when the expansion functions are eigenfunctions of $L_z(1) + L_z(2)$ and $S_z(1) + S_z(2)$. (auth)

Cosmic Radiation

Refer also to abstracts 10262, 10339, 10835, and 10837.

10399 (AD-690583) INVESTIGATION OF ANISOTROPIES AND SHORT PERIOD INTENSITY. Final Scientific Report. Sarabhai, V. A. (Physical Research Lab., Ahmedabad (India)). 9 Jul 1969. 9p. (AFOSR-69-1717-TR). CFSTI.

The report contains an investigation of the short-period intensity variations and anisotropy of the cosmic radiation measured with a very-high-counting-rate μ-meson monitor at Chacaltaya. (auth) (USGRDR)

10400 (HASL-216) CONSIDERATION OF COSMIC-RAYS AS SECONDARIES. O'Brien, Keran (New York Operations Office (AEC), N. Y. Health and Safety Lab.). Nov 1969. 24p. Dep. CFSTI.

Because of the striking resemblance of the galactic cosmic-ray proton spectrum to secondary spectra produced in nucleonic cascades, the nucleon–meson and associated electromagnetic cascades in a 600 g/cm^2 thickness of hydrogen in the Galaxy have been calculated. On irradiation by 7.5×10^{41} erg/s of high-energy protons, secondary protons, electrons, and photons emitted and transported through the Galaxy can be compared with experimental proton, electron, and photon measurements. The proton spectrum agrees with experimental data above 10 GeV. Electrons originating in $\pi \rightarrow \mu \rightarrow e$ and $n \rightarrow pe$ decay also fit the experimental data, whereas inclusion of electrons from electromagnetic showers, initiated by neutral pion decay, results in a spectrum two orders of magnitude too intense, suggesting that the emission of shower electrons is suppressed by intense magnetic and radiation fields. The fraction of positrons in the experimental cosmic electron flux is in agreement with this view, as it is approximately the value expected from decay electrons above about 10 GeV. The shape of the cosmic photon spectrum agrees with experiment. A good comparison in intensity could not be achieved however, because of uncertainties in the distribution of photon sources in the Galaxy and in the cross sections appropriate to the physical state of the hydrogen mass. In order to match the galactic proton spectrum with the spectrum of cascade proton secondaries, a thickness of about 600 g/cm^2 of hydrogen was necessary. There is no current indication of the existence of cosmic objects which would correspond to this description, which indicates that if cosmic rays are in fact secondaries, their place of origin has not been observed. (auth)

10401 PULSARS AND THE ORIGIN OF COSMIC RAYS. Ginzburg, V. L. (Academy of Sciences, Moscow). Comments Astrophys. Space Phys.; 1: 207-14(Nov-Dec 1969).

The situation concerning the sources of galactic cosmic rays as it existed before the announcement of the discovery of pulsars is outlined. The effects of this discovery on the supernovae origin of cosmic rays are discussed, and some of the possible ramifications are considered. (W.D.M.)

10402 FORBUSH EFFECT IN THE NEUTRON COMPONENT OF COSMIC RADIATION DURING THE PERIOD OF THE QUIET SUN. Akhababyan, N'shan; Stamenov, Iordan. Izv. Fiz. Inst. Aneb, Bulg. Akad. Nauk.; 19: 185-9(1969). (In Bulgarian).

The influence of magnetic storms during the period of the quiet

Sun on the intensity of the neutron component of cosmic radiation, measured at Musala Peak was investigated. A clearly pronounced Forbush effect with an amplitude reaching approximately 1% was determined. The meteorological effects slightly disguise the investigated phenomena. Thus, the decrease of the intensity of the neutron component as determined is opposite in phase to the increase of the K_p index or the H component of the geomagnetic field. (auth)

10403 SOLAR COSMIC-RAY DIFFUSION IN THE PRESENCE OF A MAGNETIC BARRIER IN INTERPLANETARY SPACE. Miroshnichenko, L. I. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 271-3(1969).

Translated from Geomagn. Aeron.; 9: 339-41(1969).

An analysis of data from several measurements by other investigators over the period Feb. 23, 1956 to Jan. 28, 1967 indicates the possibility of the existence of some effective magnetic boundary of the diffusion region at a distance of 2 to 5 AU from the Sun. The author feels that this result does not disagree with the estimates of others who give 5 to 100 AU for the radius of the sphere of modulation; rather, the difference most likely indicates that allowance must be made for the thickness of the boundary, which may attain several tens of AU, whereas measurements of solar cosmic rays on Earth give information on a region of space with a radius no greater than 10 AU. (L.M.T.)

Direct Energy Conversion

Refer also to abstracts 10037, 10136, and 10137.

10404 (AD-694906) ION INJECTORS FOR SINGLE- AND TWO-PHASE ELECTROGASDYNAMIC GENERATORS. Ober II, William Taylor (Naval Postgraduate School, Monterey, Calif.). Jun 1969. 49p. CFSTI.

Thesis.

Systems suitable for the injection of ions into electrogasdynamic (EGD) generator devices were built and tested. The mechanism of injection was based on a corona discharge, whereby ions moving through an electric field can be intercepted by a gaseous flow. The intercepted ions are of one polarity, insuring selective ion injection. Two types of injector units were investigated. One was a molecular ion device that produced ions directly from the carrier gas, and the other created larger-sized ions, resulting in an aerosol flow. The latter consisted of passing saturated steam through a corona discharge and injecting it into an air stream. In order to aid the injection process, the wake of a cylinder in the air stream was utilized in both cases. Most of the work done here was devoted to the design and testing of the aerosol flow device. The degree of success was moderate. (USGRDR)

10405 (TEE-3874-2) OUTPUT CHARACTERISTICS OF A VAPOR-DEPOSITED TUNGSTEN EMITTER AND A MOLYBDENUM COLLECTOR. Rufeh, F.; Lieb, D. (Thermo Electron Corp., Waltham, Mass.). Jun 1969. Contract AT(30-1)-3874. 123p. (TE-4086-3-70). Dep. CFSTI.

Cesium optimized performance and cesiated work functions of the emitter and collector were measured at emitter temperatures of 1600 to 2000°K. Collector temperature and ion current measurements are also reported. (D.L.C.)

10406 (TEE-3874-4) LIFE TEST ON FOUR ELECTRICALLY-HEATED THERMIONIC DIODES WITH FLUORIDE VAPOR-DEPOSITED TUNGSTEN EMITTERS. Ernst, D.; Pezaris, C. (Thermo Electron Corp., Waltham, Mass.). 30 Jun 1969. Contract AT(30-1)-3874. 73p. (TE-4086-13-70). Dep. CFSTI.

The emitters are 0.500 in. OD by 1.500 in. long, and their surfaces underwent different treatments for each of the four diodes. The collectors are niobium. Comparative performance data, in light of the vacuum work function and x-ray diffraction pole figures of the emitters, are presented along with life test data. A description is given of the equipment used. (D.L.C.)

10407 MAGNETOHYDRODYNAMIC GENERATOR DUCT FOR REDUCING THE DISADVANTAGES OF THE HALL EFFECT. Ricateau, Pierre (to Commissariat a l'Energie Atomique). British Patent 1,177,364. 14 Jan 1970. Priority date 5 Apr 1966, France.

The magnetohydrodynamic generator duct described is characterized in that the angle made by a line tangent to the transverse cross section of the duct with the direction of the magnetic field is at least 30° for 99% of the length of the perimeter of the transverse cross section. Various possible configurations satisfying this condition are described. The electrodes are formed by portions of the duct walls which are constituted by a stack of elements that are alternately conductive and insulating. Each electrode is delimited by two planes that are parallel to the equipotential planes of the duct under normal operating conditions. (M.H.R.)

10408 THEORY OF THERMIONIC CONVERTERS WITH VOLUME IONIZATION. Shustov, V. A.; Zvezdkina, T. K. (Leningrad Inst. of Physics and Tech.). Zh. Tekh. Fiz.; 39: 1913-17 (Oct 1969). (In Russian).

A system of thermionic equations is resolved, taking into account generation of ions in the volume scattering of ions, energy removal by resonance photons, and the Schottky effect. Volt–ampere characteristics obtained were compared with experimental data. The results showed that considerations of energy removal by photons, beam electrons, and the variations of ion generation rate do not affect the shape of volt–ampere characteristics. (tr-auth)

10409 THEORY OF LOW-VOLTAGE ARCS IN THERMIONIC CONVERTERS. Belokon, A. A.; Sonin, E. B. (Inst. of Semiconductors, Moscow). Zh. Tekh. Fiz.; 39: 2105-18(Nov 1969). (In Russian).

Numerical calculations were made for ions and electrons in thermionic converters in arc operations using transport equations. It is shown that arc damping taking place in the thermionic converter must be related to the energy losses on emission and diffusion of excited atoms near electrodes. Calculations indicated volt–ampere characteristics for virtual cathodes at high-current emission are in agreement with experimental data. Theoretical and experimental magnitudes of voltage for the first breaking point and potential distribution and electron concentrations and temperatures were correlated. (tr-auth)

10410 HOLLOW CATHODE IN CESIUM LOW-VOLTAGE ARC OF A THERMIONIC CONVERTER. Busygin, E. P.; Grigor'yants, V. G.; Yavor, I. P. (Leningrad Inst. of Physics and Tech.). Zh. Tekh. Fiz.; 39: 2019-24(Nov 1969). (In Russian).

It is shown that total current from a thermionic energy converter can be increased by extending cathode surfaces. Experiments carried out with a converter model with an extended cathode consisting of two molybdenum plates situated parallel to each other at 0.05 to 2.5 mm distance and perpendicular to the anode working surface are described. Data obtained on the volt–ampere and spectroscopic characteristics for diodes operating in arc conditions as a function of the cesium vapor pressure and the gap interval between the plates are analyzed. Data obtained on the plasma penetration into the cavity show that the depth of penetration depends on the density of the straight-through current, and at pressures of the order of tenths of mm Hg, high saturation is revealed. The results indicate that the increased current in converters with developed cathodes is the function of the depth of plasma penetration and the width of the gap. (tr-auth)

Fluid Physics

10411 ANNUAL REVIEW OF FLUID MECHANICS. VOLUME 1. Sears, William R. (ed.). Palo Alto, Calif.; Annual Reviews, Inc. (1969). 466p.

Separate abstracts were prepared for two of the included papers. (M.O.W.)

For abstracts of individual papers see: 10412 and 10518.

10412 ELECTROHYDRODYNAMICS: A REVIEW OF THE ROLE OF INTERFACIAL SHEAR STRESSES. Melcher, J. R.; Taylor, G. I. (Massachusetts Inst. of Tech., Cambridge). Ann. Rev. Fluid Mech.; 1: 111-46(1969).

The review of electrohydrodynamics covers information on: (1) steady convection—dc fields, (2) steady convection—ac fields, and (3) shear-induced instabilities. (M.O.W.)

10413 LORENTZ-INVARIANT ELECTROMAGNETOHYDRODYNAMICS. Saltanov, M. V. (Inst. of Hydromechanics, Kiev). Dopov. Akad. Nauk Ukr. RSR, Ser. A; No. 9, 807-9(Sep 1969). (In Ukrainian).

Ohm's law, which takes into account the Hall effect and the pressure of the "stream" component, is constructed in electromagnetohydrodynamics (EMHD) on the basis of the Lorentz-invariant hydrodynamical equations of plasma. The ultimate cases of the infinite and zero conductivities in the EMHD model are considered. The generalization of the Thomson and Helmholtz theorems is obtained under certain conditions in these cases. (auth)

10414 WEAK FLUCTUATION MODES OF AN ELECTRICALLY AND THERMALLY CONDUCTING VISCOUS INCOM-

PRESSIBLE FLUID IN A HOMOGENEOUS MAGNETIC FIELD. Stanisic, M. M.; Kovasznay, L. S. G. (Johns Hopkins Univ., Baltimore). Phys. Fluids; 13: 32-6(Jan 1970).

A method has been developed in order to extract the fundamental fluctuation modes in a slightly disturbed electrically and thermally conducting viscous incompressible fluid. The method, based on the linearized theory, consists in factorization of a fixed operator. The isolated modes have been studied separately by means of shifting and blurring operators. The theory shows that in the presence of an imposed magnetic field the propagation of the disturbed quantities is nonisotropic. (auth)

10415 A THEORETICAL INVESTIGATION OF TEMPERATURE DISPERSION IN MAGNETOHYDRODYNAMIC TURBULENCE. Coy, Brent Eugene. Lafayette, Ind.; Purdue Univ (1969). 122p. Thesis.

Temperature dispersion is considered in a weakly conducting turbulent fluid in the presence of a magnetic field. The Reynolds, Magnetic Reynolds, and Peclet numbers are taken as very large, and the Kolmogorov universal equilibrium theory is applied to the turbulent velocity, magnetic, and temperature distributions. Viscous dissipation is neglected and Joule heating is investigated as an additive effect on an already-established turbulent temperature distribution. It is hypothesized that Joule heat addition to the turbulent temperature distribution will involve one of the following processes: a continuous production of very small eddies, an infrequent production of large eddies, or an intermittent production of eddies of various sizes. The temperature spectrum for wave numbers in the velocity inertial subrange is derived for each of the three types of Joule heating. A model is developed to describe the intermittent production of Joule heat eddies of various sizes and is used to analyze the resulting temperature distribution. The theory is then extended to predict the temperature spectral form for viscous heat addition to the temperature distribution. (Diss. Abstr.)

10416 EQUATION OF ION WAVES DISPERSION IN EGD CHANNEL FLOWS OF UNIPOLAR, WEAKLY IONIZED LIQUID. Brunne, M. (Inst. of Fluid-Flow Machines, Danzig). Bull. Acad. Pol. Sci., Ser. Sci. Tech.; 17: 387-94(1969).

The perturbation method is applied to examine Poiseuille and Poiseuille–Hagen flows in order to permit the analysis of natural vibration of ions in a weakly ionized unipolar liquid flowing in axially symmetric channels. Assumptions include: the components of the mixture are in thermodynamic equilibrium; the medium is isothermal; a collision component in the Boltzmann equation is defined; a binary mixture of atoms and ions of one medium is considered; the dielectric gas of atoms contains no inherent charges; the medium is regarded as linear and homogeneous; the neutral gas is incompressible; the ionic gas is inviscid; the analysis refers to media with a low degree of ionization. Remarks concerning the propagation of small disturbances in the channels of electrogasdynamic (EGD) generators are made. The region of the EGD-conversion channel wherein small disturbances can be initiated is well defined. This is the zone where the charge emitter is located. (BBB)

10417 FLOW OF VISCOUS FLUIDS AROUND THIN PROFILES. PART II. Marcov, N. (Univ. of Bucharest). Stud. Cercet. Mat.; 20: 213-21(1969). (In Rumanian).

The flow of viscous fluids past a flat plate was further studied, obtaining an analytical expression for both low and high Reynolds numbers. An example is presented for illustrating the numerical solution for any arbitrary Reynolds number. The perturbation flow rates were expressed by potentials, using Oseen's approximation. As the nucleus has a logarithmic singularity, the equation could be reduced to a Fredholm type equation. An actual calculation is presented for the case of a profile shaped like the arc of a circle. (TTT)

Geophysics (Upper Atmosphere)

Refer also to abstracts 10270 and 10274.

10418 (AD-694567) CORRELATION BETWEEN GEOMAGNETIC MICROPULSATIONS AND IONOSPHERIC DOPPLER CHANGES. Montes, Hernan A.; Herron, Thomas J. (Isotopes, Inc., Westwood, N. J.). Aug 1969. Contract F44620-69-C-0038. 28p. (IWL-7556-156; AFOSR-69-2226-TR). CFSTI.

Observations of geomagnetic micropulsations, Doppler frequency variations, and infrasonic activity were conducted during the summer of 1968. Spectral and polarization analyses of a typical event in which there was high correlation between Doppler variations and geomagnetic micropulsations are reported. No associated infrasonic activity was found, leading to the conclusion that this type of association has a hydromagnetic origin. (auth) (USGRDR)

10419 (AD-695399) DIRECT DETECTION OF THE ASYMMETRIC INJECTION OF EXTRATERRESTRIAL "RING CURRENT" PROTONS INTO THE OUTER RADIATION ZONE. Progress Report. Frank, L. A. (Iowa Univ., Iowa City. Dept. of Physics and Astronomy). July 1969. Contracts Nonr-1509(06); NAS5-2054. 26p. CFSTI.

Measurements of the spatial distributions and temporal variations of the extraterrestrial "ring current" proton intensities near the magnetic equator during selected phases of two moderate magnetic storms provide direct evidence of asymmetric injection of these proton intensities deep into the outer radiation zone during the early development of the latter magnetic storm. Injection of these low-energy protons ($5 < E < 50$ keV) into the evening–midnight quadrant of the outer radiation zone to L shells $\simeq 3.5$ was accompanied by a substantial polar magnetic substorm observed during similar local times. However, no increases of proton intensities at levels above those typical of the "quiescent ring current" centered at $L \simeq 6.5$ were yet observed several hours later near local noon. Several implications concerning the magnetic storm are discussed. (auth) (USGRDR)

10420 (AD-848584) OV3-4 DOSE RATE AND PROTON SPECTRAL MEASUREMENTS. Technical Report, October 1963–October 1968. Thede, Allen L. (Air Force Weapons Lab., Kirtland AFB, N. Mex.). Jan 1969. 74p. (AFWL-TR-68-128). CFSTI.

Dose rate and proton spectral measurements were made in the inner Van Allen belt aboard the OV3-4 satellite during June and July 1966. The dose rates were measured by five tissue-equivalent ionization chambers shielded by 0.192 g/cm^2 aluminum, 0.745, 2.86, and 4.74 g/cm^2 lucite and 4.485 g/cm^2 brass. Analysis of data obtained from an omnidirectional proton spectrometer yielded integral proton fluxes greater than 15, 30, 55, 105, and 170 MeV. Dose rates were calculated using the OV3-4 proton environment and the shielding distributions for the ionization chambers. These calculated proton dose rates were within 50% of the measured values in regions where protons contribute most of the dose rate. Proton dose rate calculations made for sensors aboard the OV1-2, OV1-4, and OV1-9 satellites compare equally well with measurements made by those sensors. (auth)(USGRDR)

10421 (N-69-39675) DIRECT DETECTION OF THE ASYMMETRIC INJECTION OF EXTRATERRESTRIAL RING CURRENT PROTONS INTO THE OUTER RADIATION ZONE. Frank, L. A. (Iowa Univ., Iowa City. Dept. of Physics and Astronomy). Jul 1969. Contracts NAS5-2054; Nonr-1509(06). 25p. (NASA-CR-106274). CFSTI.

Measurements of the spatial distributions and temporal variations of the extraterrestrial "ring current" proton intensities near the magnetic equator during selected phases of two moderate magnetic storms provide direct evidence of asymmetric injection of these proton intensities deep into the outer radiation zone during the early development of the latter magnetic storm. Injection of these low-energy protons ($5 \leq E \leq 50$ keV) into the evening–midnight quadrant of the outer radiation zone to L-shells ≈ 3.5 was accompanied by a substantial polar magnetic substorm observed during similar local times. However, no increases of proton intensities at levels above those typical of the "quiescent ring current" centered at $L \approx 6.5$ were yet observed several hours later near local noon. Several implications concerning the origin and motions of the plasma during the early development phase of the magnetic storm are discussed. (auth) (STAR)

10422 TIME AND SPACE DISTRIBUTION OF THE WINTER ANOMALY. Tukhashvili, K. I. (Tbilisi State Univ., USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 281-2(1969).

Translated from Geomagn. Aeron.; 9: 350(1969).

Investigation of ionospheric absorption at a constant zenith angle of the Sun χ at middle latitudes at a frequency of 1.2 MHz have shown that absorption undergoes marked seasonal variations. These variations result from an increase in electron concentration in the D region. The relationship between these seasonal absorption variations and the variation in the time interval ΔT between sunrise and the time the Sun reaches the zenith angle χ = const. is examined. (W.D.M.)

10423 THE EFFECT OF THE SOLAR CYCLE ON MAGNETIC ACTIVITY AT HIGH LATITUDES. Loomer, E. I.; van Beek, G. Jansen. Publ. Dominion Observ., Ottawa; 37: No. 6, 169-80(1969).

Magnetic activity was investigated for the period 1957 to 1966, using mean hourly ranges measured in the principal horizontal component at four Canadian magnetic observatories, and the 3-hourly range A_p. The maximum magnetic activity was found to follow the solar activity maximum by about two years, occurring earliest in and north of the auroral zone. The maximum in each year occurred always in the auroral zone (Churchill). Enhancement of activity was greatest south of the zone (Meanook). A well-

defined summer maximum of activity was found in the polar cap (Resolute Bay) for all years. Annual variation for most years at auroral and subauroral stations showed two main maxima. At Churchill and Baker Lake, daytime and midnight peaks of activity behaved differently in the period from sunspot maximum to minimum, with midnight activity generally maximum about two years before sunspot minimum. Results confirm Lassen's (1963) model of an auroral zone made up of three separate zones. (auth) (Geophys. Abstr.)

10424 PARAMETERS OF THE IONOSPHERIC EFFECT OF AN SC MAGNETIC STORM AS A FUNCTION OF THE DISTANCE FROM THE SOURCE REGION. Shashun'kina, V. M. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 207-10 (1969).

Translated from Geomagn. Aeron.; 9: 259-63(1969).

A linear relationship between the increase in the period of the ionospheric effect of an SC and increasing distance from the source area in polar regions is obtained experimentally. The possible distance of propagation of the effect is determined for years of high and low solar activity and compared with the theoretical determination of the distance of propagation resulting from pulse spreading. The shapes of the diurnal Δf_0F2 curves after the SC are compared with the theoretical variations in the parameters of the neutral atmosphere after a short pressure pulse or velocity pulse of the medium. (auth)

10425 CORRELATION THEORY OF RADIO-WAVE SCATTERING IN THE POLAR IONOSPHERE. Kravtsov, Yu. A.; Goryshnik, L. L. Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 223-8(1969).

Translated from Geomagn. Aeron.; 9: 279-85(1969).

The statistical properties of auroral radio reflection signals were investigated. Allowance was made for the main characteristics of the polar ionosphere as a scattering medium and for the characteristics of the emission and reception of pulse signals. (auth)

10426 SOME CHARACTERISTICS OF THE FORM OF IONIZATION DISTRIBUTION IN THE POLAR IONOSPHERE. Sukhorukova, E. V. (Polar Geophysical Inst., Kola Branch, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 211-14(1969).

Translated from Geomagn. Aeron.; 9: 264-8(1969).

The variation in the scale height of the ionized gas, H_{eff}, at various ionospheric levels is examined. The H_{eff} values, computed on the assumption of a parabolic layer at the maximum and of Chapman distribution, differ by 10%. It is shown that H_{eff} depends on the level at which the layer maximum forms. Estimates are given of the mean electron–ion temperature at various heights. (auth)

10427 LOCAL-TIME DEPENDENCE OF GEOMAGNETIC CUTTOFFS FOR SOLAR PROTONS, $0.52 \leq E_p \leq 4$ MeV. Flindt, Herbert R. (Univ. of Iowa, Iowa City). J. Geophys. Res.; 75: 39-49(1 Jan 1970).

Low-altitude, high-latitude observations of $0.52 \leq E_p \leq 4$ MeV protons by Injun 4 are presented for three solar proton events having maximum intensities on January 20, May 30, and June 23, 1966. Only weak magnetic storms were associated with these events. A substantial body of new data is given on the magnetic local time (MLT) dependence of the geomagnetic cutoffs and the counting rate versus invariant latitude profiles from 0600 to 1300 hours and 1800 to 2200 hours for low-energy protons moving approximately normal to the local magnetic field. The observed cutoffs consist of two sets, one is independent of MLT at 66.5° invariant latitude and the upper set has marked local-time dependence, going from 68° at 0600 hours MLT to ~75° at 1000 hours and back to 68° by 1900 hours. Pitch-angle distributions were not actually measured, but an interpretation based on pitch-angle anisotropies is suggested which is consistent with the quasi-trapping suggested by Taylor and others and experimentally observed by Paulikas, Blake, and Freden. The results so interpreted yield information on the extent of the quasi-trapped region over an extensive range of local time. The boundaries are qualitatively in agreement with Taylor in the morning. (auth)

10428 REDISTRIBUTION OF TRAPPED 55-MeV PROTONS BY STARFISH NUCLEAR EXPLOSION. Cladis, J. B.; Davidson, G. T.; Francis, W. E.; Jaggi, R. K.; Nakano, G. H.; Ossakow, S. L. (Lockheed Palo Alto Research Lab., Palo Alto, Calif.). J. Geophys. Res.; 75: 57-68(1 Jan 1970).

Measurements of geomagnetically trapped 55-MeV protons made before and after the detonation of the Starfish nuclear device revealed that at low altitudes the flux increased considerably after the Starfish burst. Theoretical analyses indicate that the flux change resulted from a redistribution of the existing trapped protons in the inner zone. Two processes were found to be capable of altering the proton distribution appropriately: (1) interaction of the protons with hydromagnetic waves produced by the burst and (2) multiple reflections of the protons from a magnetic field inhomogeneity that propagates along magnetic field lines with the local hydromagnetic velocity. If the hydromagnetic velocity is determined from approximate ambient plasma densities, the latter mechanism gives an altitude dependence of the increased flux that is qualitatively in agreement with the measurements. However, much higher plasma densities, or repeated traversals of the field line by the magnetic inhomogeneity, are required to explain the magnitude of the observed flux change. (auth)

10429 STABILITY ANALYSIS OF WHISTLER AMPLIFICATION. Lee, J. C.; Crawford, F. W. (Stanford Univ., Calif.). J. Geophys. Res.; 75: 85-96(1 Jan 1970).

This paper treats whistler amplification in the magnetosphere for conditions in which an energetic group of electrons interacts with the background plasma to produce wave growth. For the energetic group, the following forms of velocity distributions have been examined: pancake, anisotropic resonance, anisotropic Maxwellian, and an isotropic Maxwellian with loss-cone. The work is distinguished from nearly all previous studies in that each case is subjected to rigorous stability analysis to determine whether the predicted instability should cause wave growth in time, or in space. This is very important in determining whether whistlers will be amplified when passing through an active region, or whether the region will simply be the site of continuous noise generation. The broad general conclusions of the work confirm that the presence of any anisotropy such that the particle energy transverse to the magnetic field is greater than that parallel to the magnetic field always causes instability in some sense. For the cases examined, the instability is generally amplified spatially until this ratio reaches some critical value, and temporally for further increases. The results are discussed in relation to observed whistler amplification and vlf emissions. (auth)

10430 THREE-DIMENSIONAL MODEL CURRENT SYSTEM FOR POLAR MAGNETIC SUBSTORMS. Bonnevier, Bjoern (Royal Inst. of Tech., Stockholm); Bostroem, Rolf; Rostoker, Gordon. J. Geophys. Res.; 75: 107-22(1 Jan 1970).

A model current system, in which magnetospheric and ionospheric sections are connected by currents flowing along the geomagnetic field lines, is proposed to represent the current system responsible for polar magnetic substorms. The magnetic perturbations from model current systems of this type are studied in terms of elementary loops, whose magnetic effects are evaluated numerically. The influence of currents induced in the ground is studied for a time-independent case, but it is found that such effects do not change the gross character of the perturbation pattern. Using a north–south chain of stations and an appropriate coordinate system, the model predictions are compared with the magnetic variations observed during some substorms. It is found that the model is capable of explaining the gross features of the magnetic perturbation pattern observed. However, at times there are minor deviations from the predictions, which suggest the presence of additional ionospheric and magnetospheric current systems. (auth)

10431 TEMPORAL BEHAVIOR OF ENERGETIC PARTICLE PRECIPITATION DURING AN AURORAL SUBSTORM. Whalen, B. A.; McDiarmid, I. B. (National Research Council of Canada, Ottawa). J. Geophys. Res.; 75: 123-32(1 Jan 1970).

Results from two rocket experiments launched from Fort Churchill Research Range into the breakup and post-breakup phases of an auroral substorm are described. Unusual characteristics were observed in energy spectra and pitch-angle distributions of energetic electrons ($E > 23$ keV) and protons ($E > 28$ keV) simultaneously with the arrival of the northern edge of a series of northward-propagating auroral arcs. When the northern edge passed the rocket, electron intensities increased and the spectrum hardened appreciably, both changes occurring with time constants less than about 2 seconds. Dispersion in arrival times of electrons was observed with the low-energy particles arriving first. After the initial injection the particle fluxes were observed to decay at rates consistent with the maximum decay rates for these latitudes. Decay times of the order of a few minutes for electrons and a few hours for protons were observed. Electron angular distribution characteristics were found to be energy dependent. The recovery-phase of the substorm was found to be characterized by soft isotropic electron precipitation. (auth)

10432 POSITIVE ION COMPOSITION FROM A ROCKET-BORNE MASS SPECTROMETER. Goldberg, R. A.; Blumle, L. J. (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res.; 75: 133-42(1 Jan 1970).

On March 15, 1968, at 1411 LMT, a Nike Tomahawk was launched from Wallops Island, Virginia, carrying a quadrupole

mass spectrometer for measurements of positive ion composition in the ionosphere. The instrument was enclosed in a vacuum system principally controlled by a titanium getter pump and marks the first attempt to use this technique for rocket experiments. A cw radio propagation experiment plus ground-based ionosonde results enabled the reduction of the data to absolute values. On upleg, the spectrometer was opened at 98 km and provided well-resolved spectra in the ram direction up to an apogee of 303 km, slightly above the F2 peak. The sweep range from 13 to 49 amu enabled all major constituents to be determined, and the high sensitivity of the spectrometer allowed many minor constituents, having densities as low as 2 to 5/cm^3, to be detected. On downleg, measurements were restricted to wake composition, but values obtained at higher altitudes were similar to those seen on upleg. Upon entry into the D region, the vacuum system permitted spectra to be obtained to 68 km. D-region results between 80 and 68 km show a predominance of 19^+ and 37^+ ions, possibly due to complex water clusters, marking the first independent observation in agreement with the earlier results of others. (auth)

10433 BACKSCATTER OBSERVATIONS OF F-REGION FIELD-ALIGNED IRREGULARITIES DURING THE I.Q.S.Y. Baggaley, W. J. (Sheffield Univ., Eng.). J. Geophys. Res.; 75: 152-8(1 Jan 1970).

Field-aligned irregularities were observed in the F region by using a 17-MHz swept-azimuth sounder operating in the United Kingdom during the period 1964 to 1966. The occurrence of echo activity was less than that reported in previous studies and is attributed to the solar-cycle effect. The diurnal variation of echoes and their spatial characteristics are those expected on established models of high-latitude spread F when effects of ionospheric refraction are considered. (auth)

10434 SEASONAL VARIATION OF THE F1-REGION ION COMPOSITION. Evans, J. V.; Cox, L. P. (Massachusetts Inst. of Tech., Lexington). J. Geophys. Res.; 75: 159-64(1 Jan 1970).

Thomson scatter observations at a wavelength of 23 cm are described that supplement earlier ionospheric studies made at the Millstone Hill Radar of the region 130 to 230 km. By making certain reasonable assumptions about the altitude dependence of the electron and ion temperatures, it has been possible to recover from the observations the ratio of atomic ions (O^+) to molecular ions (O_2^+ or NO^+) in this region. A marked seasonal variation is found with O^+ extending to lower altitudes in winter than in summer. The results suggest a seasonal variation of the abundance of neutral atomic oxygen that has not yet been detected in rocket-borne ion mass spectrometer measurements. (auth)

10435 ASPECT SENSITIVITY OF F-LAYER HF BACKSCATTER ECHOES. Bates, Howard F.; Albee, Paul R. (Stanford Research Inst., Menlo Park, Calif.). J. Geophys. Res.; 75: 165-70(1 Jan 1970).

The method proposed recently to estimate the aspect sensitivity of hf auroral echoes from the E layer is extended to aspect-sensitive echoes from the F layer. Nearly all the F-layer echoes observed at College, Alaska, can be classified into two types, oblique spread-F echoes and auroral echoes. By utilizing the F-supported ground-scatter echo to account for ionospheric refraction quantitatively, it is found that most of the F-layer aspect-sensitive echoes observed at College originated at off-perpendicular angles from the magnetic field of less than 5°. The aspect-sensitive decrease of the backscatter cross section for F-layer backscatter echoes was probably of the order of 5 db per degree of off-perpendicularity from the magnetic field. When recent E-layer results are considered, it is concluded that the assumption of strict aspect sensitivity is an excellent approximation for all hf, high-latitude aspect-sensitive echoes. (auth)

10436 DECAMETER AND METER WAVELENGTH RADAR STUDIES OF ARTIFICIAL PLASMA CLOUDS IN THE LOWER IONOSPHERE. I. THERMODYNAMIC PROPERTIES OF THE ATMOSPHERE DISCERNED FROM BLAST WAVE MEASUREMENTS. Davis, John R.; Moore, John C. (Naval Research Lab., Washington, D. C.). J. Geophys. Res.; 75: 171-82(1 Jan 1970).

A series of cesium-seeded explosive bursts in the 90- to 110-km altitude region were observed with meter- and decameter-wave radar. Detailed measurements of contact surface expansion, undulation, and stabilization were used to acquire estimates of the altitude dependence of atmospheric pressure and density in the lower ionosphere. It was found that events in the development of the contact surface are retarded relative to those predicted by Brode's blast wave model, and this retardation is interpreted as evidence of magnetohydrodynamic effects upon the blast wave. Comparison of the results of these observations with previous results of Rosenberg (1964, 1965) suggests that a suitable combination of optical and radio-frequency instrumentation can be utilized to study in detail both the neutral gas and the magnetofluid characteristics of the lower ionosphere simultaneously. (auth)

10437 SOME DRIFT OBSERVATIONS BY RADIO REFLECTIONS FROM E_s. Armstrong, R. J.; Lue, T. (Univ. of West Indies, Kingston, Jamaica). J. Geophys. Res.; 75: 183-92(1 Jan 1970).

Some results obtained at Kingston, Jamaica, by ground-based radio reflection from the E_s layer are discussed. Evidence is presented for the presence of irregularities of at least several kilometers in extent and also for the presence of oscillatory behavior with periods of some minutes. It would seem that the Miltra method has applications where the receivers are much further separated than has been previously noted. (auth)

10438 OBSERVATIONS OF THE PLASMAPAUSE FROM OGO 5. Harris, K. K.; Sharp, G. W.; Chappell, C. R. (Lockheed Palo Alto Research Lab., Palo Alto, Calif.). J. Geophys. Res.; 75: 219-24(1 Jan 1970).

The data from the ion spectrometer aboard the OGO 5 vehicle were analyzed for the early orbits. The profiles of O^+, He^+, and H^+ ion concentrations were obtained as a function of the geomagnetic parameter L. The detailed character of the plasmapause was observed. It was found that the concentration change at the plasmapause location is highly variable being at times gradual and at other times very abrupt. The diameter of the plasmasphere was found to depend upon the magnetic activity, showing a significant decrease when the magnetic activity is high. The plasmapause is found to occur independently in all ion species at precisely the same location. An interesting "wavelike" structure in the ion concentration was observed in the vicinity of L = 6. (auth)

10439 RAPID FLUCTUATIONS OF ENERGETIC AURORAL PARTICLES. Arnoldy, R. L. (Univ. of New Hampshire, Durham). J. Geophys. Res.; 75: 228-32(1 Jan 1970).

Rapid fluctuations in the intensity of precipitated energetic particles during a bright aurora were measured at rocket altitudes with a single counter. This counter was aboard a series of Nike-Tomahawk rocket flights launched from Fort Churchill. (W.D.M.)

10440 ELECTRIC FIELDS IN THE MAGNETOSPHERE OF THE EARTH. Tverskoi, B. A. (Moscow State Univ.). Dokl. Akad. Nauk SSSR; 188: 575-8(21 Sep 1969). (In Russian).

Perturbations were observed in the radiation belts on the basis of satellite data. This new physical effect is due to the creation of an asymmetric, hot plasma loop and its subsequent symmetrization. The dynamics of this process is assumed to be due to the following factors: the asymmetric perturbation is small with respect to the symmetric distribution of the particles and the plasma pressure gradient is also small in comparison with the magnetic pressure gradient of the dipolar field. It was also noted that the conductivity along the lines of force in the ionosphere and above is infinite, and the Hall and Petersen conductivities differ from zero only in a thin spherical layer and are independent of latitude and longitude. The data also indicate that the plasma is displayed on the lines of force which enter the ionosphere at high latitudes and the processes conserve the magnetic moment and the invariance of longitudinal action. The calculations yield only an order of magnitude approximation, as certain factors, such as the daily variation of conductivity, is not taken into account. (TTT)

10441 PLASMA ACOUSTIC PROPAGATION IN THE IONOSPHERE. Iyengar, R. S. (Mount Allison Univ., Sackville, New Brunswick). Nature (London); 224: 1191-2(20 Dec 1969).

A discussion is presented on how a new implication of the plasma acoustic theory (Farley, J. Geophys. Res. 68: 6083(1969)) may be related to some optical, magnetic, and radio observations of auroras. Since the concept of instabilities in the equatorial electrojet was extended to the case of the auroral electrojet, auroral radio studies have tended in this direction. Peak occurrence of echoes at 100 to 120 km and 350 m/s were obtained in some of the investigations, whilst from others a peak echo occurrence at 110 km and average speeds of 310 m/s are suggested. In the latter case, morning echoes could not have been due to plasma acoustic propagation and in the former a "threshold effect" was observed in relation to the magnetic events. This means that echoes appeared only when the intensity of the electrojet and, hence, the magnetic field exceeded a minimum value. An examination was made of some experimental results on optical, magnetic, and radio effects obtained at Saskatoon (magnetic latitude 60°) in relation to plasma acoustic propagation in the ionosphere. Some salient points about such propagation are first reviewed. Among these are that a detailed correspondence would be expected to be observed between radio backscatter and magnetic activity below the reflecting region; such a correspondence was in fact observed

under good auroral conditions at Saskatoon. The so-called "threshold effect," however was not noticeable. With regard to heights of propagation, although 100 to 120 km was the mean height for the peak occurrence of echoes, some came from greater heights. Assuming that the echoes were from the inhomogeneities of ionization caused by the plasma acoustic waves, the latter appear to have been propagating even above 120 km. The speed of propagation of the waves is also calculated; they do not represent plasma acoustic speeds. A further related effect is considered—the irregularities of ionization are caused along the field lines, and the wavefront propagates at right angles to the field lines, and it is wondered whether this effect should not be observable in some manner in auroral luminosity effects. If this were so, it would imply a new interpretation of the plasma acoustic effect. (UK)

10442 IONOSPHERIC EFFECT OF X RAYS FROM SCORPIUS XR-1. Poppoff, I. G.; Whitten, R. C. (Ames Research Center, Moffett Field, Calif.). Nature (London); 224: 1187-8(20 Dec 1969).

Reference is made to recently reported observations of the field strength of 164-kHz radio waves transmitted from Tashkent, USSR, to Ahmedabad, India, in which it was found that short-lived decreases in field strength could be correlated with transits of the x-ray source in Scorpius (Ananthakrishraan and Ramanathan, Nature 223: 488(1969)). The interpretation made by these authors was that the x radiation ionizes the upper atmosphere sufficiently to cause ionospheric attenuation of the radio waves, and if this is correct it would be an "exciting discovery," with many significant ramifications for theories of nocturnal ionospheric processes. The present communication examines the physics of such an interaction. The ionization rate profile due to Sco XR-1 is first calculated, and then compared with specific ionization rate profiles due to other nighttime sources (the solar lyman-α radiation which is scattered by the geocorona into the dark hemisphere of the Earth, and galactic cosmic rays). These three profiles of ionization rate are shown, and it is apparent that the rate of ionization due to x rays from Sco XR-1 is much smaller than the sum of the other two rates below 90 km. Because of the rapid formation of negative ions below ~90 km at night, and the consequent lack of free electrons, most of the absorption of 164-kHz radio waves probably occurred above ~85 km. The contribution of positive ions is also found to be negligible. From this analysis it is concluded that neither Sco XR-1 nor other x-ray sources outside the solar system can have an effect on the Earth's observable ionosphere. (UK)

10443 VLF WAVE GENERATION BY THE CHERENKOV PROCESS IN THE INNER MAGNETOSPHERE. Singh, R. P.; Singh, R. N. (Banaras Hindu Univ., India). Nature (London); 225: 49-50(3 Jan 1970).

Support is presented for the Cherenkov process for the generation of electromagnetic waves of very low frequencies; in such a process radiation is produced by the interaction of moving electrons with the ambient plasma. The vlf power radiated by an influx of 10 eV electrons is calculated and it is shown that the measured vlf power can be easily explained by the Cherenkov process. The Cherenkov power radiated by a 10-eV electron is found to be 2.6×10^{-28} W Hz^{-1}, and since the influx of 10-eV electrons is 2×10^{7} m^{-3}, the total power density of the Cherenkov radiation is 5.2×10^{-21} W Hz^{-1} m^{-3}. The radiated power is found to increase with increasing frequency, which is consistent with experimental predictions and calculations. Vlf waves propagate along field lines and are received on the ground, and it is necessary to evaluate the integrated vlf power at certain frequencies. It is found that the total power radiated at 10 kHz by 10-eV electrons is of the order of 2.5×10^{-14} W m^{-2} Hz^{-1}. It is difficult, however, to estimate the integrated power at a given frequency since electrons of different energies contribute significantly to the intergrated power at the given frequency. Measurements reported at 8.8 kHz (L = 1.1 and altitude 350 km) of the order of 10^{-13} W m^{-2} Hz^{-1}, are in fair accordance with the calculations. It is concluded that the Cherenkov process is chiefly responsible for vlf wave generation at low latitudes. (UK)

10444 THE DYNAMICAL BEHAVIOR OF THE NIGHTTIME F LAYER AT HAWAII. Brown, Walter Edward. Honolulu, Hawaii; Univ. of Hawaii (1969). 293p.

Thesis.

The dynamical state of the nighttime F layer between 14° and 28° N. magnetic latitude near Hawaii was inferred from measurements of the [OI] 6300Å line in the night airglow made with a scanning photoelectric photometer. In addition, the ionospheric electron content at two points within the observational circle of the scanning photometer was measured using the Faraday rotation of radio signals from two geostationary satellites, and a fixed photometer was aimed at the ionospheric point of one of these satellites. A second fixed photometer was aimed vertically so as to receive the emission from directly above the ionosonde at Maui, Hawaii. (TSS) (Diss. Abstr.)

10445 RADIO ASTRONOMICAL INVESTIGATIONS OF THE PARAMETERS OF LARGE-SCALE IONOSPHERIC INHOMOGENEITIES. Kokurin, Yu. L.; Kovura, Yu. A.; Ovsyankin, M. A. (Lebedev Inst. of Physics, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 215-19(1969).

Translated from Geomagn. Aeron.; 9: 269-74(1969).

Data on the anisometry, dimensions, and drift velocity of large ionospheric inhomogeneities are obtained from the results of simultaneous measurements of irregular ionospheric refraction at three spaced points. (auth)

10446 STEADY-STATE CHARGE NEUTRAL MODELS OF THE MAGNETOPAUSE. Alpers, W. (European Space Research Inst., Frascati, Italy). Astrophys. Space Sci.; 5: 425-37(Dec 1969).

Plane models of the magnetopause are investigated under the assumption that ionospheric electrons are able to short-circuit electric fields (exact charge neutrality). Using the Vlasov theory a general method is presented for constructing distribution functions that lead to given magnetic field and tangential bulk velocity profiles. As an example the magnetic field transition is described in terms of error functions and particle distributions are obtained in explicit form, including bulk velocities. It is thus shown that bulk velocities in the direction of the magnetic field do not necessarily lead to a nonequilibrium magnetopause which investigations by Parker and Lerche seem to suggest. (auth)

Low-Temperature Physics

Refer also to abstracts 10027, 10061, 10093, and 10614.

10447 OFHC-COPPER-STABILIZED SUPERCONDUCTORS FOR STRONG MAGNETIC-FIELD WINDINGS. Cuivre, Laitons, Alliages; No. 109: 20-7(May-Jun 1969). (In French).

Loss of superconductivity in a strong magnetic field is reviewed with reference to its inhibition by surrounding the superconductor with O-free high-conductivity (OFHC) Cu. Reasons for choosing Cu as the stabilizer are presented, and construction of the large (4.8 m internal dia.) coil serving the 3.6-m-dia. cloud chamber at the Argonne National Laboratory is described; this comprises 32.5 tons of OFHC-Cu ribbon surrounding 12.7 tons of superconducting Ni–48% Ti windings. In a similar application at Brookhaven the Cu ribbon is channelled to circulate the liquid-He refrigerant, and the Ni–Ti coil carries 6000 A at 4.2°K, with a maintenance current of 6 kW. Magnetohydrodynamic and other applications of the stabilized superconductors are mentioned. (Metals Abstr.)

10448 QUANTUM OSCILLATIONS IN THE SUSCEPTIBILITY OF A SUPERCONDUCTING TIN MICROCYLINDER. McLachlan, D. S. (Univ. of Witwatersrand, Johannesburg). Phys. Rev. Lett.; 23: 1434-7(22 Dec 1969).

The susceptibility of a thin-walled microcylinder is measured as a function of magnetic field at various temperatures, and oscillations due to fluxoid quantization are observed. In order to explain the magnetization close to T_c, where the phase transition is of second order, the expression for the flux in a thin-walled microcylinder derived by several authors must be used to relate the observed increments in magnetization to the absolute quantum of the fluxoid. (auth)

10449 CHANGE IN VELOCITY OF SOUND BETWEEN NORMAL AND SUPERCONDUCTING TIN FOR ql gt 1. Yee, B. G. W.; Deaton, B. C. (General Dynamics, Fort Worth, Tex.). Phys. Rev. Lett.; 23: 1438-40(22 Dec 1969).

Measurements of the change in the velocity of sound of shear and compressional waves at the normal-to-superconducting transition have been made in a high-purity tin single crystal. The changes observed are of the order of a few parts in 10^4, are electronic in origin, and agree qualitatively with theory for the shear-wave case. (auth)

10450 NUCLEATION OF QUANTIZED VORTEX RINGS BY IONS IN HELIUM II. Donnelly, Russell J.; Roberts, Paul H. (Univ. of Oregon, Eugene). Phys. Rev. Lett.; 23: 1491-5(29 Dec 1969).

It is suggested that a quantized vortex ring is formed when a roton, localized near a moving ion, is expanded by stochastic processes to become a small ring, attached to the ion. Calculations based on this notion are compared with experiment. (auth)

10451 MAGNETIC PROPERTIES OF TYPE-II SUPERCONDUCTORS IN THE TWO-BAND MODEL. Sung, C. C. (Ohio State Univ., Columbus). Phys. Rev.; 187: 548-55(10 Nov 1969).

It has been suggested previously by Wong and Sung that the present discrepancies between theory and experiments on the magnetic properties of some transition metals which are intrinsic type-II superconductors (e.g., Nb) may be caused by the overlapping-band effect of s and d bands. The numerical results of this effect on the magnetic properties is presented here. It is shown that the overlapping-band effect in the pure limit can reduce the upper critical field H_{c2} about 30 to 60% at T close to temperature T_c, and thus enhance the over-all temperature dependence of H_{c2}. The amount of reduction decreases as the superconductors become dirtier. Reasonable parameters which characterize the overlapping-band effect are assumed. Also κ_2, which defines the slope of H_{c2} when the external field is slightly less than H_{c2}, was computed. It is found that κ_2 becomes smaller in comparison with the present theory as $T \to T_c$; thus a stronger temperature dependence is also associated with κ_2. The numerical value of this correction in κ_2, however, is very sensitive to the parameters used. (auth)

10452 THERMAL CONDUCTIVITY OF SUPERCONDUCTING NIOBIUM. Wasim, S. M.; Zebouni, N. H. (Louisiana State Univ. and Agricultural and Mechanical Coll., Baton Rouge). Phys. Rev.; 187: 539-48(10 Nov 1969). (ORO-3087-34).

Thermal-conductivity measurements on niobium of intermediate purity ($l \simeq \xi_0$) were performed in the normal, superconducting, and mixed states. The lattice and electronic components of the conductivity in the superconducting state are separated. The critical temperature and the energy gap are found to be $T_c = (9 \pm 0.1)°K$ and $2\epsilon(0) = 3.96\ kT_c$. The temperature dependence of the minimum in the thermal conductivity in the mixed state suggests a decrease in both the phonon and the electron conductivities just above H_{c1}. The comparative importance of each depends on a combination of temperature range and purity of the sample. The slope $\partial K_m/\partial H$ and upper-critical-field parameter $\kappa_1(t)$ are found to change with temperature much faster than predicted by relevant theories. (auth)

10453 STRUCTURE OF VORTEX LINES IN PURE SUPERCONDUCTORS. Bardeen, John (Univ. of Illinois, Urbana); Kuemmel, R.; Jacobs, A. E.; Tewordt, L. Phys. Rev.; 187: 556-69 (10 Nov 1969).

A method is given for solving the Bogolyubov equations for quasi-particle excitations in superconductors in the WKBJ approximation. It is applied to calculate the excitation spectrum and the scattering states of an isolated vortex line in a type-II superconductor. The pair potential and magnetic field in the vicinity of the core are determined by a variational method. For values of the Ginzburg–Landau parameter κ near 1, the energy so calculated is about 10% too high and the critical κ for type-II superconductivity about 25% too high, indicating that the variational functions used are only approximately of the correct form. The energy of the bound states depends on the magnetic quantum number like a Landau energy; the effective magnetic field is of the order of the upper critical field H_{c2} for all values of κ. (auth)

10454 VARIATION OF THE RATIO H_{c3}/H_{c2} IN THE IMMEDIATE VICINITY OF T_c. De La Cruz, Francisco; Maloney, M. David; Cardona, Manuel (Brown Univ., Providence). Phys. Rev.; 187: 766-7(10 Nov 1969).

The ratio H_{c3}/H_{c2} was measured for tin-rich Sn–In alloys and for indium-rich In–Bi alloys in the immediate vicinity of T_c. For the Sn–In system this ratio decreases as T_c is approached. Similar behavior has been recently reported by Ostenson and Finnemore for pure Nb. The In–Bi alloys, however, show a marked increase in H_{c3}/H_{c2} as the critical temperature is approached. (auth)

10455 OBSERVED LARGE DEVIATION OF THE SUPERCONDUCTIVE CRITICAL-FIELD RATIO H_{c3}/H_{c2} FROM THE EXISTING THEORIES NEAR T_c. Hu, Chiaren (Univ. of Illinois, Urbana). Phys. Rev.; 187: 574-9(10 Nov 1969).

The ratio H_{c3}/H_{c2} is calculated in the presence of a phonon-mediated interaction which is slightly depressed in a surface layer. It is shown that if the surface layer has a thickness of order ξ_0, then this ratio will drop rapidly to unity as the transition temperature is approached from below. This result is in good agreement with the recent observation by Ostenson and Finnemore, who reported that for temperatures very close to T_c, the ratio H_{c3}/H_{c2} falls far below the factor 1.7 of Saint-James and de Gennes. A mean-field-theory explanation of this phenomenon is given. (auth)

10456 BOSON FORMALISM IN SUPERCONDUCTIVITY. Leplae, L.; Umezawa, H. (Univ. of Wisconsin, Milwaukee). J. Math. Phys. (N. Y.); 10: 2038-46(Nov 1969).

After a brief summary of the results obtained previously concerning the boson formalism in superconductivity, the formalism is generalized to include finite temperature and Coulomb interactions. Finally, as an illustration, the formalism is used to derive the Landau–Ginzburg equations and to study the vortices in type-II superconductors. (auth)

10457 FLUX PENETRATION AND SURFACE LOSSES IN NIOBIUM. Buchhold, Theodor A.; Rhodenizer, Richard L. (General Electric Co., Schenectady, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Magnet.; MAG-5: 429-33(Sep 1969).

Measurements made on cylindrical niobium samples with test coils in ac magnetic fields of 290-Hz frequency have shown that the superconducting penetration depth λ can be expressed as $\lambda = \lambda_0 + aH^2 + bH^4 + \cdots$, where λ_0 is the penetration depth at zero field and H is the surface field. In the region of H = 800 to 1300 gauss, λ can be approximated as $\lambda = \lambda_0 bH^4$, where $\lambda_0 = 580$ Å, $b = 8.3 \times 10^{-12}$ Å/G^4. The voltage waveforms from the test coils displayed on an oscilloscope showed good agreement with predicted curves based on this penetration depth. From the voltage signals surface losses could be determined. Loss measurements made on cylinders of niobium with cold-worked surfaces gave surprising results. The measured losses were low if the sample was cooled to the measuring temperature quickly, but the losses could be several hundred times higher if the cooling rate was slow. After the sample was annealed, the losses were low and independent of the cooling rate. Data are also given for loss measurements at various temperatures. (auth)

10458 DESTRUCTION OF TYPE-I SUPERCONDUCTIVITY BY A CURRENT IN A CYLINDRICAL WIRE. Rothen, F.; Bestgen, W. (Univ., Lausanne, Switzerland). Phys. Lett.; 30A: 509-10(29 Dec 1969).

The transition time of the isothermal destruction of type-I superconductivity in a cylinder by a current is computed as function of the total current J for values of J/J_c not exceeding 2, J_c being equal to the critical current. (auth)

10459 APPARATUS FOR STUDYING SUPERCONDUCTIVITY AT PRESSURES UP TO 50 KBAR. Vereshchagin, L. F.; Il'ina, M. A.; Itskevich, E. S. (Inst. for High Pressure Physics, Moscow). Cryogenics; 9: 477-8(Dec 1969).

An apparatus has been designed to operate under quasihydrostatic pressure up to 100 kbar, using a previously described high-pressure chamber, for determining the pressure dependence of the superconducting transition temperature of metals and alloys. The apparatus is a double intensifier system. The first intensifier is always at room temperature and can produce oil pressures up to 10 kbar on the high-pressure side. The oil, under high pressures, is then fed through a stainless steel capillary passing through the cap of the helium dewar to the low-pressure chamber of the second intensifier. (UK)

10460 ULTRASONIC ATTENUATION IN DIRTY TWO-BAND SUPERCONDUCTORS WITH PERSISTENT CURRENTS. Kolpagiu, M. K.; Kon, L. Z. (Moldavian Academy of Sciences, USSR). Phys. Lett.; 30A: 530-1(29 Dec 1969).

The ultrasonic attenuation in two-band superconductors with nonmagnetic and paramagnetic impurities in the presence of persistent currents is studied. The case of high-impurity concentrations is considered. Assuming space-independent sound waves, the absorption energy in the case of relatively low frequencies at low and zero temperatures is calculated. (auth)

10461 FLOATING-MAGNET MODEL OF THE FLUXON LATTICE IN A TYPE-II SUPERCONDUCTOR. Rose-Innes, A. C.; Stangham, E. A. (Univ. of Manchester, Eng.). Cryogenics; 9: 456-9(Dec 1969).

Mutually repelling magnets floating in a trough of water are used to simulate the fluxons threading the mixed state of a type-II superconductor. The lattice taken up by the magnets and the faults present in this lattice are compared with the fluxon lattice and faults that have been observed in the mixed state of a type-II superconductor. (auth)(UK)

10462 TEMPERATURE DEPENDENCE OF AC LOSSES IN SUPERCONDUCTING NIOBIUM. Rogers, E. C.; Redmonds, B. E.; Chan, G. D. (British Insulated Callender's Cables Ltd., London). Cryogenics; 9: 431-42(Dec 1969).

A method is described for measuring the ac losses in a superconducting niobium strip as a function of temperature. The design principles, the experimental procedure, and the means adopted for reducing various sources of error are discussed. The measured losses depend on the method of preparing the sample edges and are least when the edges are folded. Results are given for the 50-Hz loss per unit area ($\mu W/cm^2$), ϕ, in a sample of 25-μm-thick niobium strip with folded edges, and it is shown that they can be expressed by the empirical relationship $\log_{10}\phi = A\psi + [B/(1 - t^2)] - C$, where ψ is the current per unit width (A/cm), $t = T/T_c$ is the reduced temperature ($T_c = 9.1$ K), and A, B, and C are constants, having the values 5.18×10^{-3}, 1.72, and 4.02, respectively. (auth)(UK)

10463 COLLECTIVE EXCITATIONS OF SUPERCONDUCTORS. Bajorski, Z. (Wroclaw Polytechnic). Acta Phys. Pol.; 36: 951-62(Dec 1969).

The solutions of the equations for collective excitations in superconductors, which have been derived in the case of S pairing and P pairing by Bogolyubov and Czerwonko, respectively, are refined. The energy spectrum is calculated up to the first correction term. The equivalent calculations for the Coulomb term are also presented. (auth)

10464 HEAT FLOW BELOW 100°K AND ITS TECHNICAL APPLICATIONS. Proceedings of the International Institute of Refrigeration, Commission 1, Grenoble 1965. Pure and Applied Cryogenics. Volume 4. New York; Pergamon Press Inc. (1966). 364p. $12.00. (In French and English). (CONF-650611).

Subjects covered are: heat transfer in solids, liquids, and powders; heat transfer to liquid nitrogen and hydrogen; heat transfer in missiles and space operations; and heat transfer to liquid helium. (M.H.R.)

10465 FERROMAGNETISM AND SUPERCONDUCTIVITY IN URANIUM COMPOUNDS. Matthias, B. T.; Chu, C. W.; Corenzwit, E.; Wohlleben, D. (Bell Telephone Labs., Murray Hill, N. J.). Proc. Nat. Acad. Sci. U. S.; 64: 459-61(Oct 1969).

The intimate correlation between the mechanisms causing magnetism and superconductivity in uranium compounds has been verified again—in novel systems. (auth)

10466 HIGH-PRESSURE SUPERCONDUCTING POLYMORPH OF CADMIUM GERMANIUM DIARSENIDE. Katzman, H. (Univ. of California, Los Angeles); Donohue, T.; Libby, W. F.; Luo, H. L. J. Phys. Chem. Solids; 30: 2794-6(Dec 1969).

The high-pressure behavior of $CdGeAs_2$ was studied. The low-pressure semiconducting form has an energy gap of 0.53 eV and the chalcopyrite crystal structure with a = 5.942A and c/a = 1.889. It is found that under pressure it undergoes a phase transition to a more-dense superconducting metal. At 60-kbar pressure, the same polymorph was formed at all temperatures in the 300 to 800°C range. The structure of this polymorph was studied. (UK)

10467 NEW THREE-COMPONENT SUPERCONDUCTING COMPOSITES. Barber, A. C. (Imperial Metal Industries Ltd., Birmingham, Eng.); Smith, P. F. Cryogenics; 9: 483-4(Dec 1969).

Three-component composites containing both Cu and CuNi have been developed. The NbTi filaments are each enclosed in a CuNi sheath, and these composite filaments are situated in a pure copper matrix; all components are metallurgically bonded. The composite is twisted to ensure that the filaments behave essentially independently from the viewpoint of stability and ac losses. (UK)

10468 APPLICATIONS OF CRYOGENIC TECHNOLOGY. A Compilation of the Lectures Presented at the Cryogenic Technology Symposia of CRYO-68, June 9-12, 1968, Chicago, Illinois. Vance, Robert W.; Weinstock, Harold (eds.). Los Angeles; Tinnon-Brown, Inc. (1969). 349p. $14.95. (CONF-680622).

Eleven papers are included, a separate abstract was prepared for one. Other subjects discussed are: cryogenic history and principles, radiation heat transfer at cryogenic temperatures, heat exchangers, cryogenic surgery, life support systems for sealed environments, liquid hydrogen for commercial uses, liquefied natural gas, vacuum technology, hazards of cryogenic liquids, and cryogenics in space communications. (M.H.R.)

For an abstract of the individual paper see: 10469.

10469 SUPERCONDUCTING DEVICES AND APPLICATIONS. Hulm, J. K.; Henning, C. D.; Sass, A. R.; Gaule, G. K. (Westinghouse Research Labs., Pittsburgh). pp 273-318 of Applications of Cryogenic Technology. /Vance, Robert W.; Weinstock, Harold (eds.). Los Angeles; Tinnon-Brown, Inc. (1969).

From 4th Annual Cryogenic Exposition and Technology Symposium, Chicago, Ill. See CONF-680622.

Recent progress and future prospects in four areas of potential application of the phenomenon of superconductivity are summarized. The applications considered are power systems, high field electromagnets, computer memories, and high frequency applications. (M.H.R.)

10470 OCCURRENCE OF A15 PHASES. Luo, H. L.; Vielhaber, E. (Univ. of California, San Diego, La Jolla). Z. Phys.; 230: 443-8(1970).

Three binary A15 compounds (Zr_4Sn, Ta_3Sb, Ta_4Au) were reinvestigated and all three found to be superconducting below 1°K. Ternary compounds $V_3(Al, X)$, (X = As, Ge, Au) were also investigated in the composition range where the A15 structure is stable. The extrapolated superconducting transition temperature of the compound V_3Al, if it existed in the A15 form, is ~17°K. (auth)

10471 ULTRASONIC ATTENUATION IN LIQUID HELIUM AT 1 GHz. Imai, James Susumu. Los Angeles; Univ. of California (1969). 62p.

Thesis.

The ultrasonic attenuation in liquid helium at 1 GHz was measured from about 1.1 to 4.2°K. The experiment gives a direct measurement of the absolute attenuation over the entire temperature range. The results are described in terms of three regions: a classical normal fluid region above 2.3°K, a critical region near the lambda transition, and a superfluid region below 2.0°K. In the normal fluid region, the attenuation is due to classical shear viscosity and thermal conductivity, and is described by the Stokes–Kirchhoff equation. The results give good agreement, except for a gradually increasing surplus as T approaches the lambda transition, when compared with the theoretical Stokes–Kirchhoff attenuation curve. In the critical region, the results are shown to differ in a fundamental way from those found at lower frequencies. The Landau–Khalatnikov order parameter relaxation mechanism is shown to contribute insignificantly to the attenuation in this region. In addition to the absolute attenuation measurements, the relative attenuation was measured in this region by a continuous drift in temperature. These measurements, when combined with the absolute attenuation, show a very large non-singular peak of about 2000 cm^{-1} centered at or very nearly at the lambda transition. The slopes of the attenuation peak, when fitted to a power law of the form $\alpha = (A/|T_\lambda - T|^n)$, give $A = 2.4 \times 10^2$ $(°K)^n/cm$, $n = 0.41$ for $T > T_\lambda$, and $A = 1.5 \times 10^2$ $(°K)^n/cm$, $n = 0.52$ for $T < T_\lambda$. Although recent theoretical treatments cite exponents for the power law ranging from $\frac{1}{3}$ to 1, they contain an assumption about the convergence of the specific heat, C_p, to an asymptotic value, which is not valid over the temperature region for which the critical behavior of the attenuation was determined. A comparison of the measurements with these theoretical results would thus be improper. In the superfluid region, the attenuation measurements show the local maximum at 1.5°K which separates the hydrodynamic from the collisionless regime. The results are shown to be in agreement with the elementary excitation relaxation theory of Khalatnikov and Cherenikova. They differ at lower temperatures from the results obtained from Brillouin scattering measurements. (Diss. Abstr.)

10472 EXPERIMENTAL INVESTIGATION OF THE EFFECT OF DEPTH ON FILM BOILING IN LIQUID HELIUM II. Steed, Ronald Craig. Gainesville, Fla.; Univ. of Florida (1968). 173p.

Thesis.

The effect of liquid height above a test surface undergoing film-boiling heat transfer in liquid helium II (the depth effect) was investigated experimentally. High-purity (99.999%) platinum wires, 0.005- and 0.008-in. diameter, were the test surfaces used as both heater and thermometer. Temperature differences from 80 to 400 K at heat fluxes up to 20 watt/cm^2 were generated. Four bath temperatures (2.13, 2.05, 1.81, and 1.50 K) were taken, and depths up to 26 cm were recorded. For changes in depth from 1 to 20 cm at a given temperature difference, the heat flux increased up to 75%. The results demonstrated that geometry changes of up to 75% in the heat path to the surface and of up to 50% in the volume above the test surface do not affect the heat transport provided that the depth is held constant. An analysis of motion-picture films produced values for wavelength of vapor-film oscillations in the range from 9×10^{-2} to 2×10^{-1} cm. Vapor-film diameters were found in the range 6.6×10^{-2} to 2.8×10^{-1} cm and were dependent on the bath temperature, the heat flux, and the depth of the liquid above the test surface. The film diameters were used to show that the vapor/liquid interface heat flux is a function of the bath temperature and the depth, not of the test-section heat flux. In addition, an interface heat-transfer coefficient was defined and was determined to be a function of the bath temperature only. This result supports the conclusions that the depth effect is due to changes in the interface temperature difference which accompanies changes in depth and that the depth effect occurs because of the highly efficient heat-transport mechanism in helium II. (Diss. Abstr.)

10473 SURFACE PHENOMENA AND OTHER EFFECTS IN TYPE-II SUPERCONDUCTORS. Mattes, Hans George. Los Angeles; Univ. of Southern California (1969). 222p.

Thesis.

The critical irreversible current I(S) was determined in several type-II superconductors (e.g., NbTa, PbIn, NbZr). These measurements provide evidence that an irreversible paramagnetic current arises at the surface of a sample as it becomes superconducting in a static H. Further, the observations indicate that this current is subcritical at low fields, $O \leq H \leq H(c1)$, and critical in the range $H(c1) \leq H \leq H(c2)$. A transient heat pulse, preferentially warming up the surface, destroys this field retaining current and

thereby allows the specimen to expel some flux and exhibit a final diamagnetism approaching the ideal Abrikosov diamagnetism. Next, it is verified that I(S) has been quenched by monitoring the resulting opposition to either entry or exit of flux when the external field is varied. It is reported also that the critical I(S) is strongly dependent on previous history. In particular, the ability of the surface to oppose entry of flux is appreciably depressed when flux is trapped in the specimen. This result is at variance with the Bean–Livingston model of a surface barrier arising from an image force experienced by flux lines in the surface. The Meissner effect was reexamined in rods of pure Pb in axial fields. A perfect Meissner effect was observed, provided the sample is cooled gradually from the transition temperature, T(c). Flux expulsion is incomplete when the sample is cooled rapidly, i.e., quenched. Another new phenomenon was encountered. The trapped flux escapes and the Meissner effect approaches ideal when the surface is perturbed by a transient heat pulse and also when the temperature is gradually increased toward T(c). These effects are attributed to the appearance during quenching of a surface layer capable of supporting irreversible currents. This proposal is partly substantiated by investigation of the entry and exit of flux when the external field is varied after quenching. The current-carrying capacity of hysteretic superconductors is markedly influenced by the previous history of the applied field. It is reported that the critical current, I(c), of NbZr and NbTi wires in stationary axial fields also depends strongly on the history of the conduction current itself. An appreciable degradation in I(c) was observed after impressing a half-cycle of conduction current of opposite polarity when the half-cycle amplitude exceeds a threshold value. A simple explanation is presented that describes the main features of the observation. According to the model, the threshold current provides a measure of the axial current-carrying capacity of the surface layer in longitudinal fields. The rate of propagation of flux jumps along the axis of Nb and NbZr wires in axial fields was monitored as a function of conduction current and temperature. The observed velocities appear independent of these variables and coincide remarkably closely with the velocity of transverse phonons in these materials. Finally, a new magnetic phenomenon in type-II superconductors is reported. A magnetic moment is generated along the axis of a wire sample immersed in a static axial field when a transverse field, H(⊥), is applied or removed. The axial moment generated under these circumstances is paramagnetic when H(⊥) is applied, diamagnetic when H(⊥) is removed. This effect is qualitatively attributed to the generation of competing Lorentz forces. (TSS) (Diss. Abstr.)

10474 GROUND STATE OF LIQUID ^{4}He. Francis, W. P. (Univ. of Windsor, Ont.); Chester, G. V.; Reatto, L. Phys. Rev., A; 1: 86-97(Jan 1970).

A trial wave function describing the ground state of a quantum system of N interacting bosons is written in the Jastrow form, a product of pair functions. With the interaction potential chosen to represent liquid ^{4}He, and with the parametrized form of the pair function chosen to include a long-range term which has been found necessary to represent the zero-point motion of the long-wavelength density oscillations, a variational calculation has been performed using a new approximate integral equation for the pair distribution function. This equation, which can also be used for classical fluids, is found to be more accurate for repulsive potentials than the Percus–Yevik equation and comparable to (but much simpler than) the Percus–Yevick 2 equation. The essential results are that including the zero-point motion in the wave function tends to lower the energy, raises the equilibrium density, corrects the behavior of the structure function and the momentum distribution of the particles in the low-wave-number region, and slightly decreases the Bose–Einstein condensate fraction. The value of the lower limit on the wavelength of the density oscillations was determined variationally to be about three interparticle spacings. (auth)

10475 ENERGY AND MOTION OF VORTEX RINGS IN LIQUID HELIUM II IN THE PRESENCE OF VARIOUS PLANE OBSTACLES. Walraven, A. (Philips Research Labs., Eindhoven, Netherlands). Phys. Rev., A; 1: 145-57(Jan 1970).

A classical calculation is given for the kinetic energy of a vortex ring in an inviscid fluid (He II) in the presence of an infinitely extended plane, a coaxial circular disk, and an infinitely extended plane with a coaxial circular aperture. The energy is obtained as an explicit function of the ring position relative to the obstacle being considered. Formulas are given for the velocity components of the vortex-ring motion, the force exerted on an obstacle by a stationary vortex ring, and the impulse of the vortex ring in the presence of the obstacle. In the case of the circular aperture, there is found to be a critical energy (or ring size) beyond which a vortex ring cannot pass through the aperture. The path of the vortex ring near the different obstacles is obtained by numerical computation, departing from the explicit energy expression. The calculation method is easily extended to other axisymmetric configurations and consists of Fourier and Hankel integral-transform techniques in combination with results from the theory of dual integral equations. (auth)

10476 RIPPLE THEORY OF SURFACE TENSION IN SUPERFLUID HELIUM. Widom, Allan (Northeastern Univ., Boston). Phys. Rev., A; 1: 216(Jan 1970).

The ripple theory of surface tension in superfluid helium, originated by Atkins and developed by Brouwer and Pathria, implies a surface instability. (auth)

10477 EFFECT OF ELASTIC STRESS ON SOME ELECTRONIC PROPERTIES OF INDIUM. Overcash, D. R.; Skove, M. J.; Stillwell, E. P. (Clemson Univ., S. C.). Phys. Rev.; 187: 570-4(10 Nov 1969).

The effect of elastic stress to 0.3 kbar was measured on the resistance at room and helium temperatures and on the superconducting transition temperature of In whiskers. These whiskers have diameters of about 1 μ and axes parallel to a closest-packed or ⟨101⟩ direction. $\partial T_c/\partial\sigma$ is 51 ± 7 mK/kbar, in disagreement with results obtained by measuring the change in length of In crystals as they pass through the superconducting transition. At room temperature, $\Delta\rho/\rho\sigma = a + b\sigma$, where $a = (-0.4 \pm 0.2) \times 10^{-5}$ bars^{-1} and $b = (14 \pm 2) \times 10^{-9}$ bar^{-2}. (auth)

10478 HIGH-ENERGY EXCITATIONS IN LIQUID HELIUM. Woods, A. D. B.; Cowley, R. A. (Atomic Energy of Canada Ltd., Chalk River, Ont.). pp 609-14 of Neutron Inelastic Scattering. Vol. I. Vienna; International Atomic Energy Agency (1968).

From Symposium on Inelastic Neutron Scattering, Copenhagen, Denmark. See STI/PUB-187(Vol.1); CONF-680501-(Vol.1).

The scattering of neutrons from liquid helium at 1.1°K was studied by use of a rotating-crystal spectrometer and a triple-axis crystal spectrometer. Measurements were made at both larger energy and momentum transfers than in earlier experiments where the existence of phonons and rotons was demonstrated. An additional ill-defined excitation branch was found at momentum transfers, Q, of less than 2Å^{-1}. Its intensity was comparable with that of the phonon branch, its mean energy was almost constant at about 24°K, and its full width at half height was approximately equal to its energy. At larger momentum transfers the mean energy of this excitation increased and, above 3Å^{-1}, was almost the free particle energy, $\hbar^2Q^2/2M$. The width of this scattering increased, on average, linearly with Q up to the limit to the measurements, 9Å^{-1}, and in magnitude was consistent with an independent-particle model and McMillan's ground state wave function of liquid helium. Additional structure was also observed in the width, however, and this possibly arises from the creation of vortex rings. (auth)

10479 A SELF-CONTAINED AUTOMATIC LIQUID NITROGEN TRANSFER SYSTEM. Buhler, S.; Chalfen, J. B. (Institut de Physique Nucleaire, Orsay, France). Nucl. Instrum. Methods; 77: 173-4(1970).

A description of an automatic LN_2 transfer system working with maximum–minimum level sensors is given. It is energized only by the pressure of the storage container. (auth)

10480 TUNNELING DETERMINATION OF PHONON-ENERGY UNCERTAINTIES DUE TO FORCE-CONSTANT DISORDERS IN THE ALLOY $Pb_{1-2x}Tl_xBi_x$. Dynes, R. C.; Rowell, J. M. (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev.; 187: 821-7 (15 Nov 1969).

Superconducting tunneling measurements of the alloy system $Pb_{1-2x}Tl_xBi_x$ were performed, and a determination of the product function $\alpha^2(\omega)F(\omega)$ for these alloys is reported. It is found that with this system, Tl and Bi can be added at least up to x = 0.2 before a change of phase from the fcc structure results. Because the electron concentration remains fixed at 4 e/at. throughout this phase, the electron–phonon coupling is not severely changed and the superconducting properties remain relatively unchanged. Associated with a gradual shift to lower energies of the phonon modes is a slight upward trend in the measured energy gap of the alloys. It is also found that with higher alloy concentrations there is a smearing of the fine structure in the product function $\alpha^2(\omega)F(\omega)$ and this is associated with finite lifetimes of the phonon modes resulting in energy uncertainties. In a simple quantitative fashion an attempt was made to attribute these smearings to force-constant disorders between ions, and numbers were obtained for the deviations of interatomic force constants from their mean values. (auth)

10481 PHONON FREQUENCIES AND SUPERCONDUCTIVITY IN VERY THIN FILMS. Allen, R. E.; De Wette, F. W. (Univ. of Texas, Austin). Phys. Rev.; 187: 883-4(15 Nov 1969).

Moments of the phonon frequency distribution have been

calculated for very thin crystalline films and used to estimate electron–phonon coupling constants and superconducting transition temperatures. The results are found to depend strongly on the crystallographic orientation of the film. (auth)

10482 INFLUENCE OF EXTERNAL NOISE ON MICROWAVE-INDUCED JOSEPHSON STEPS. Kose, V. E.; Sullivan, D. B. (NBS Inst. for Basic Standards, Boulder, Colo). J. Appl. Phys.; 41: 169-74(Jan 1970).

The influence of fluctuations on microwave-induced Josephson steps is treated phenomenologically and it is found that the center voltage of these steps is not shifted by the disturbance. Expressions governing the step shape are obtained for various noise spectra. The theory was checked by subjecting niobium point-contact junctions to several forms of externally generated noise. The theory does not differentiate between internal and external noise sources, so that a number of the conclusions can be extended to intrinsic fluctuations. (auth)

10483 FLUCTUATION ENHANCEMENT OF THE ELECTRICAL CONDUCTIVITY ABOVE THE SUPERCONDUCTING TRANSITION. Laramore, George E.; Kadanoff, Leo P. (Univ. of Illinois, Urbana). Comments Solid State Phys.; 2: 105-9(Oct-Nov 1969).

Fluctuations in the order parameter ψ as $T \to T_c$ lead to regions where superfluid density (Cooper pairs) is temporarily nonzero above T_c; an electric field can accelerate these regions, increasing the conductivity. Theoretical and experimental studies of this effect in bulk, films, and wires are reviewed. The case where fluctuations become very large and the Ginzbury–Landau theory breaks down is also considered. (D.L.C.)

10484 LOW TEMPERATURES AND ELECTRIC POWER. Conference Held at London, England, 24th–26th March 1969. London; Institution of Electrical Engineers (1969). 281p. (CONF-690329).

Thirty-six papers and synopses of seven survey lectures are included. Separate abstracts were prepared for four papers. (M.H.R.)

For abstracts of individual papers see: 10485–10488.

10485 SOME FUNDAMENTAL PROBLEMS ON SUPERCONDUCTING ENERGY STORAGES. Frie, F.; Yamafuji, K. (Kyushu Univ., Japan). pp 39-46 of Low Temperatures and Electric Power. London; Institution of Electrical Engineers (1969).

From Conference on Low Temperatures and Electric Power, London, England. See CONF-690329.

One of the most promising applications of superconducting coils is in energy storage devices, and there appears to be some possibility of such an application in electrical power systems. Materials used in such coils are non-ideal type-II superconductors with high magnetic critical fields, such as Nb–Zr, Nb–Ti, and Nb_3Sn. The magnetization of such a material shows large hysteresis, which represents part of the losses in a superconducting coil, and this kind of loss is dominant when the current is not changed very rapidly. This hysteresis loss in a superconducting coil is discussed quantitatively, together with losses in room temperature devices connected to the coil. 4 references. (UK)

10486 EFFECT OF TEMPERATURE ON THE CRITICAL CURRENT DENSITY OF Nb-44 WT. PERCENT Ti ALLOYS. Hampshire, R.; Sutton, J.; Taylor, M. T. (Central Electricity Research Labs., Leatherhead, Eng.). pp 69-76 of Low Temperatures and Electric Power. London; Institution of Electrical Engineers (1969).

From Conference on Low Temperatures and Electric Power, London, England. See CONF-690329.

There is an increasing interest in the operation of superconducting magnets in helium vapour at temperatures above 4.2°K (the normal boiling point of liquid helium), and in order to predict magnet performance at these temperatures it is necessary to know the temperature dependences of the critical current density (J_c) vs magnetic field (H) curves of the superconductor. Measurements are reported of J_c vs H on Nb–44 wt % Ti alloy at temperatures up to the transition temperature (T_c). The parameter $\delta J_c/\delta T$ is also required in an analysis of the thermal stability of a current-carrying type-II superconductor, and in the absence of measured value it is usually assumed that this parameter is constant for temperatures below T_c. The present measurements show that this assumption is remarkably good for the alloy studied. It is concluded that the operation of superconducting magnets at temperatures above 4.2°K appear advantageous only with designs using adiabatic stabilization, and then only for low field magnets. Adiabatic stabilization is achieved by never allowing the superconductor to become normal, and stabilization depends on fine subdivision of the superconductor. 6 references. (UK)

10487 STABLE SUPERCONDUCTORS AND THEIR USES. Morton, P. H. (Imperial Metal Industries Ltd., Birmingham, Eng.). pp 186-93 of Low Temperatures and Electric Power. London; Institution of Electrical Engineers (1969).

From Conference on Low Temperatures and Electric Power, London, England. See CONF-690329.

The stability of a superconducting coil is a measure of the extent to which it is capable of operating at up to the critical current as measured in a short sample. In an incompletely stabilized coil, heat generation as a result of flux jumps causes the conductor to revert to normal at a prematurely low current. Stability can be achieved in two ways: either by minimizing the effect of local normal regions, or by preventing them from occurring. In the first method it is necessary to combine the superconductor with a good normal conductor in a composite and to provide controlled cooling. Study of the theory of flux jumps has, however, led to the development of inherently stable superconductors in which flux jumps can be virtually eliminated. Both approaches are discussed. There are two methods of making intrinsically stable composites: by employing fine filaments in a copper matrix, or fine filaments in cupronickel or other high resistivity matrix. The advantages and disadvantages of each method are discussed. 8 references. (UK)

10488 DEVELOPMENT AND APPLICATIONS OF Nb–Ti AND Nb–Sn SUPERCONDUCTORS. Adam, E.; Dosdat, J. (Thomson CSF, Chatou, France). pp 246-53 of Low Temperatures and Electric Power. London; Institution of Electrical Engineers (1969).

From Conference on Low Temperatures and Electric Power, London, England. See CONF-690329.

The superconducting materials Nb–Ti and Nb–Sn have a large potential field of application for energy storage devices, their large critical field H_{c2} permitting realization of coils producing intense fields of up to 6 Tesla in volumes of the order of a cubic metre, and perhaps up to 15 Tesla in a more restricted volume. The following aspects of the use of these materials are discussed: development of simple and composite Nb–Ti conductors (choice of alloy; procedure for utilization; examples of realization); development of Nb_3Sn composite conductors (physical properties of Nb_3Sn; processes for diffusion of Sn in Nb; mechanical and superconducting properties); and applications. (UK)

10489 T MATRIX FOR PURE SUPERCONDUCTORS JUST ABOVE THE TRANSITION TEMPERATURE. Valladares, Ariel A. (Univ. Nacional de Mexico, Mexico City). Rev. Mex. Fis.; 18: 379-95(1969).

The many-body T matrix is calculated for a system of fermions interacting only through a simple two-body attractive interaction just above the superconducting transition temperature β_c^{-1}. This model has been discussed by Kadanoff and Martin who have shown that the appearance of a complex pole in the T matrix as a function of temperature, for zero energy and momentum, signals the transition to the superconducting phase. Here the T matrix for total momentum and energy different from zero is evaluated. (auth)

10490 EMPIRICAL FORMULA FOR THE MEASURED HALL ANGLES OF DIRTY TYPE-II SUPERCONDUCTORS. Weijsenfeld, C. H. (Philips Research Labs., Eindhoven, Netherlands). Physica; 45: 241-52(24 Nov 1969).

Measurements of the magnetic field and current dependence of the Hall angle in the mixed state of Pb–Bi alloys are presented. These and other measurements published in literature are analyzed in terms of the flux flow models where the mixed state Hall angle equals the "normal" state Hall angle in the vortex core. It is found that the values of the electron relaxation time in the core, needed to fit the measured data, are in excellent agreement with the superconducting order parameter relaxation time $\tau_g = \hbar/\pi\Delta$ (which in dirty type-II superconductors is orders of magnitude larger than the bulk normal relaxation time). The modification of the electron density, now needed to fit the resistivity of the quasinormal core, is in agreement with the requirements for a local description and with the Ginzburg–Landau equations. (auth)

10491 PSEUDOPOTENTIAL CALCULATION OF THE MASS ENHANCEMENT AND SUPERCONDUCTING TRANSITION TEMPERATURE OF SIMPLE METALS. Allen, Philip B.; Cohen, Marvin L. (Univ. of California, Berkeley). Phys. Rev.; 187: 525-38(10 Nov 1969).

A calculation is presented of the electron–phonon mass-enhancement parameter λ and the superconducting transition temperature T_c for sixteen simple metals plus Ca, Sr, and Ba. Empirical pseudopotentials and phonon spectra are used to calculate the electron–phonon coupling in a one-orthogonalized-plane-wave approximation using a spherical model of the phonons and the Fermi surface. Umklapp processes are explicitly evaluated. Calculated values of λ are compared with values of λ

extracted from T_c and with values of the enhancement of the density of states at the Fermi surface as measured by the low-temperature specific heat. Excellent agreement is found for the divalent hexagonal metals, using empirical nonlocal pseudopotentials. Satisfactory agreement is found for the other simple metals. It is predicted that Li and Mg should be superconducting at low temperatures. The calculated results are also compared with a simple model for λ due to McMillan, and the simple model is used to discuss the occurrence of superconductivity in the Periodic Table. (auth)

10492 ARE THERE THERMOELECTRIC EFFECTS IN SUPERCONDUCTORS? Putterman, Seth (Rockefeller Univ., New York); de Bruyn Ouboter, R. Phys. Rev. Lett., 24: 50-2 (12 Jan 1970).

A comparison between He II when the normal fluid is clamped and the superconducting state of metals leads to an extension of the two-fluid equations of London. The following consequences are discussed: (a) A nonstationary thermal emf (thermal electric effect) can exist in a superconductor, and (b) a stationary potential difference (not an emf) can exist. (auth)

10493 SUPERCONDUCTIVITY IN THE NIOBIUM–TECHNETIUM SYSTEM. Giorgi, A. L.; Szklarz, E. G. (Los Alamos Scientific Lab., N. Mex.). J. Less-Common Metals; 20: 173-5(Feb 1970).

The superconductivity of a series of Nb–Tc alloys was studied. The addition of small concentrations of technetium to the niobium resulted in a marked decrease in the superconducting transition temperature. The crystal structure and lattice parameters were determined from x-ray diffraction studies. The solid solution was found to obey Vegard's Law. (G.M.C.)

Plasma and Thermonuclear Physics

Refer also to abstract 9705.

10494 PLASMA PHYSICS INDEX. VOLUME 4, NO. 10, 1969. Bibliography, Author Index, Subject Index. Frankfurt am Main; Zentralstelle fuer Atomkernenergie-Dokumentation (1969). 219p.

Four hundred and fifty-one articles on various aspects of plasma physics are listed. (M.O.W.)

10495 ADVANCES IN PLASMA PHYSICS. VOLUME 3. Simon, Albert; Thompson, William B. (eds.). An Interscience Series. New York; John Wiley and Sons, Inc. (1969). 254p. $14.95.

Separate abstracts were prepared for the three individual sections. (M.O.W.)

For abstracts of individual sections see: 10550, 10551, and 10595.

Confinement and Heating

Refer also to abstracts 10525, 10571, and 10572.

10496 (AEC-tr-7108) MASS-ENERGY MEASUREMENTS OF PLASMA CAPTURED INTO THE APERTURE OF THE DIVERTOR DURING INJECTION THROUGH THE MAGNETIC GAP. Zalkind, V. M.; Zykov, V. G.; Karpukhin, V. I.; Rudnev, N. I.; Tolok, V. T. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). Translation of report NP-17665. 12p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 23: 3441. (M.O.W.)

10497 (AEC-tr-7115) TURBULENT HEATING OF PLASMA IONS DURING THE DEVELOPMENT OF ELECTRON-ACOUSTIC INSTABILITY. Sizonenko, V. L.; Stepanov, K. N. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). Translation of report FTI-218. 27p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 23: 36642. (M.O.W.)

10498 (SC-RR-69-836) TIME-DEPENDENT COLLISIONLESS PLASMA SHEATH. Poukey, J. W. (Sandia Labs., Albuquerque, N. Mex.). Dec 1969. 33p. Dep. CFSTI.

A collisionless, fully ionized plasma located between two infinite plane walls is investigated by means of computer simulation. Since there are no sources of ionization, the plasma is eventually all lost to the walls, the loss being greatly inhibited by the positively charged negative-potential sheath which forms near the walls. The solutions depend on three parameters: the ratios of Debye length to system size, electron temperature to ion temperature, and ion mass to electron mass. Certain aspects of the solutions, such as the sheath structure, diffusion cooling, and the current to the wall, are considered in detail. (auth)

10499 (SC-T-70-4001) PENETRATION OF A NEUTRALIZED ION–ELECTRON BEAM INTO A MAGNETIC BARRIER. CONDITIONS AFFECTING THE HEIGHT OF THE BARRIER. I. Dolique, J. M. Translated by Marcel I. Weinreich (Sandia Labs., Albuquerque, N. Mex.), from Compt. Rend.; 256: 3984-7(1963). 5p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 17: 28370. (M.O.W.)

10500 THE LIMITS OF APPLICABILITY OF THE ADIABATIC THEORY OF THE MOTION OF CHARGED PARTICLES OSCILLATING BETWEEN MAGNETIC MIRRORS. Dubinina, A. N. At. Energ. (USSR); 27: 475-6(Nov 1969). (In Russian).

In the design of a thermonuclear reactor, it must be taken into account that if the conditions relating to the adiabatic motion are violated, the charged particles escape from the operational space, even if it is possible to neglect scattering by the residual gas and the plasma instability. The critical criterion of adiabaticity determines the lifetime of the charged particles oscillating between the mirrors. The case of an axially symmetric trap is examined, considering conditions under which the critical parameter of the motion reaches a maximum. On this basis, an equation is derived to determine the conditions under which electrons and other charged particles do not leave the operational space because of nonadiabatic effects. (TTT)

10501 INFLUENCE OF TEMPERATURE PERTURBATIONS ON PLASMA DIFFUSION IN TOROIDAL SYSTEMS. Galeev, A. A. (Inst. of Nuclear Physics, Novosibirsk, USSR). JETP Lett. (USSR) (Engl. Transl.); 10: 225-8(5 Oct 1969).

Translated from Zh. Eksp. Teor. Fiz. Pis'ma Redaktsiyu; 10: 353-7(5 Oct 1969).

The two-fluid magnetohydrodynamic equations describing the plasma were solved using the method of expanding in the toroidality parameter. The fact that the correction to the particle temperature T_1 turns out to be inhomogeneous in space even if there is no gradient of the unperturbed temperature ($T_0(v)$ = const.) is taken into account. (M.O.W.)

10502 CROSS FIELD CONVECTION OF PLASMA IN A PARTIALLY IONIZED GAS. Hooper, E. B. Jr. (Yale Univ., New Haven). Phys. Fluids; 13: 96-102(Jan 1970).

The $E \times B$ instability generates a drift wave in a partially ionized gas that causes plasma transport across the magnetic field. It is believed to be important in reflex arcs and in the ionosphere. A nonlinear model of the transport is given in the limit of collisionless electrons. A solution is found which demonstrates that the transport in the model is convective in nature with characteristics similar to results obtained in a reflex arc. (auth)

10503 PLASMA CONVECTION AND PARTICLE LOSS. Harries, W. L. (Princeton Univ., N. J.). Phys. Fluids; 13: 140-3(Jan 1970).

Afterglow plasmas in a linear quadrupole showed the same anomalous loss rate from a region where density fluctuations were undetectable (peak-to-peak fluctuation/average density <1%) as from turbulent regions. The possibility that convective cells may be responsible for the anomalous loss from the quiescent region is discussed. (auth)

10504 PLASMA CONFINEMENT IN dc OCTOPOLE. Ohkawa, T.; Yoshikawa, M.; Kribel, R. E.; Schupp, A. A.; Jensen, T. H. (Gulf General Atomic Inc., San Diego, Calif.). Phys. Rev. Lett.; 24: 95-8(19 Jan 1970).

Containment of a gun-injected hydrogen plasma in the dc octopole has been studied. The plasma parameters are $n = 10^8$ to 10^{11} cm^{-3}, $T_e = 1$ to 5 eV. The confinement of 300 Bohm times is observed. The plasma losses across the magnetic field are comparable to the support loss. In high-density regimes the loss process is found to be due to classical diffusion. (auth)

Diagnostics

10505 (AD-695052) TRANSIENT PROBE DIAGNOSTICS OF DENSE PLASMAS. Final Report, June 11, 1965–May 31, 1967. Sheer, C.; Tschang, P. S.; Stojanoff, C. G. (Columbia Univ., New York. Electronics Research Labs.). Jul 1969. Contract AF33(615)-3165. 185p. (F-334; ARL-69-105). CFSTI.

Accomplishments of a two-year project on the development of transient probes for the diagnostics of moderately dense (0.1 to 10 atm) plasmas are described. The types of probes investigated include a Hall magnetic probe, a thermocouple probe, a fiber optics probe, and a dynamic pressure (Pitot tube) probe. In each case the sensing element or probe tip is driven through the hot plasma at high speeds (e.g., 1 to 7.5 m/sec) and immersion times are restricted to the millisecond range. The sensing elements are

miniaturized so as to respond to plasma conditions as localized as possible, and to reduce perturbations of the plasma itself. Fast response instrumentation is utilized to provide a direct measure of the variation of plasma parameters along the line of the probe traverse. Short immersion times plus some insulation are relied upon to prevent thermal damage to the probes. (auth)(USGRDR)

10506 (ORO-3393-7) APPLICATIONS OF LIGHT SCATTERING TO PLASMA DIAGNOSTICS. Progress Report. Griem, Hans R.; Kunze, H.-J. (Maryland Univ., College Park. Dept. of Physics and Astronomy). Nov 1969. Contract AT(40-1)-3393. 32p. Dep. CFSTI.

Status reports are given on the following: (1) measurement of excitation rate coefficients for lithium-like ions; (2) measurement of excitation rate coefficients for beryllium-like ions; (3) the vacuum spark; and (4) the high electron density–low temperature scattering experiment. Papers presented at national and international conferences are listed. One reprint, "3s–3p Transitions of Ne VII and Ne VIII," is included. (auth)

10507 (SC-CR-69-3203) DEVELOPMENT OF A MODIFIED CHAPMAN–ENSKOG SOLUTION OF THE LENARD–BALESCU EQUATION FOR FULLY IONIZED TWO-TEMPERATURE PLASMAS. Walters, Wallace F.; Everett, Willis L. (New Mexico Univ., Albuquerque. Bureau of Engineering Research). Jun 1969. Contract 48-7021. 74p. Dep. CFSTI.

For Sandia Labs., Albuquerque, N. Mex.

The Lenard–Balescu equation is utilized to determine the characteristic transfer frequencies associated with a tenuous test-particle stream interacting with a two-temperature Maxwellian hydrogen plasma. A set of ordered equations are then obtained with the appropriate ordering parameter $\epsilon = (M_e/M_i)^{\frac{1}{2}}$. Utilizing this ordering parameter, a modification of the classical Chapman–Enskog method of solution is systematically developed. (auth)

10508 OPTICAL LINE MODULATION BY ELECTRON-PLASMA OSCILLATIONS. Stern, R. A.; Cheo, P. K. (Bell Telephone Labs., Whippany, N. J.). Phys. Rev. Lett.; 23: 1426-30(22 Dec 1969).

Efficient modulation of atomic-line-emission intensity by high-frequency plasma oscillations (~4 GHz) is observed through the use of a heterodyne down-conversion technique. Applications in atomic and plasma diagnostics are detailed. (auth)

10509 LINEAR AND NONLINEAR BEHAVIOR OF LASER PRODUCED ALUMINUM PLASMAS. Engelhardt, A. G.; George, T. V.; Hora, Heinrich; Pack, J. L. (Westinghouse Research Labs., Pittsburgh). Phys. Fluids; 13: 212-14 (Jan 1970).

Framing-camera and energy-absorption studies of aluminum plasmas produced from single spheres 50 to 130 μm in radius indicate linear and nonlinear behavior. (auth)

10510 TWO-WAVELENGTH HOLOGRAPHIC INTERFEROMETRY OF PARTIALLY IONIZED PLASMAS. Jeffries, R. A. (Los Alamos Scientific Lab., N. Mex.). Phys. Fluids; 13: 210-12(Jan 1970).

A transient partially ionized plasma has been observed by two-wavelength holographic interferometry. Electron-density measurements of plasmas that are less than fully ionized are possible by use of this diagnostic technique. (auth)

10511 RELATIVISTIC KINETIC EQUATIONS FOR PLASMA, COULOMB FIELDS, AND RADIATION. Lerche, I. (Univ. of Chicago). Phys. Fluids; 13: 166-81(Jan 1970).

Equations are derived for the correlations between particles and fields in a plasma. The plasma may be relativistic or thermal; there may exist external electric and magnetic fields as well as the induced fields. The equations place particles, longitudinal (i.e., Coulomb) fields, and radiation fields all on the same footing. The equations represent the relativistically generalized chain of kinetic equations. The chain is "solved" to first order in a generalization of the Rosenbluth and Rostoker expansion scheme. In lowest order the relativistic Vlasov equation and the relativistic one-oscillator statistical Maxwell equations result. In first order, correlation equations are obtained which demonstrate that particle–particle, particle–wave, and wave–wave correlations are all the same order in general. A method is given for solving the first-order equations. The equations are sufficiently general that bremmstrahlung, synchrotron, and cyclotron radiation, radiative diffusion, particle diffusion, etc., can be extracted, although some effort might be required to elucidate any specific effect in view of the complexity of the resulting equations. (auth)

10512 THEORY OF A PROBE IN A STRONG MAGNETIC FIELD. Sanmartin, Juan R. (Univ. of Colorado, Boulder. Princeton Univ., N. J.). Phys. Fluids; 13: 103-16(Jan 1970).

An asymptotic analysis of the Langmuir-probe problem in a quiescent, fully ionized plasma in a strong magnetic field is performed, for electron cyclotron radius and Debye length much smaller than probe radius, and this not larger than either ion cyclotron radius or mean free path. It is found that the electric potential, which is not confined to a sheath, controls the diffusion far from the probe; inside the magnetic tube bounded by the probe cross section the potential overshoots to a large value before decaying to its value in the body of the plasma. The electron current is independent of the shape of the body along the field and increases with ion temperature; due to the overshoot in the potential, (1) the current at negative voltages does not vary exponentially, (2) its magnitude is strongly reduced by the field, and (3) the usual sharp knee at space potential, disappears. In the regions of the C–V diagram studied, the ion current is negligible or unaffected by the field. Some numerical results are presented. The theory, which fails beyond certain positive voltage, yields useful results for weak fields, too. (auth)

10513 DETERMINATION OF ELECTRON ENERGY DISTRIBUTION IN PLASMA IN PRESENCE OF OSCILLATIONS. Kazan, Yu. M.; Milenin, V. M.; Mitrofanov, N. K.; Smirnov, V. L. (Leningrad State Univ.). Zh. Tekh. Fiz.; 39: 1985-8(Nov 1969). (In Russian).

Electron energy distribution in a moving plasma was studied. It is shown that it is impossible to use a universal probe method for measuring electron energy distributions in an oscillating plasma in the case in which the oscillation amplitude is considerable and electron distribution function varies considerably with time. For such a case, the electron distribution can be determined only by means of instantaneous measurements based on the formula developed by Druyvesteyn. (R.V.J.)

10514 ULTRASONIC PROPAGATION IN HIGH-TEMPERATURE GASES AND PLASMAS. Uva, Samuel. Chestnut Hill, Mass.; Boston College (1968). 183p.

Thesis.

An ultrasonic pulse method (1 to 3 MHz) was used to measure both sound speed and absorption in monatomic and polyatomic gases in a temperature range of 300° to 20,000°K and at atmospheric pressure. In monatomic gases in a temperature range where no ionization occurs, the ultrasonic technique described may be used to determine shear viscosity and thermal conductivity. This has been reported in another writing. In nitrogen and oxygen, in the range of 5000° to 10,000°K, relaxation times due to the excitation of bound electrons were determined. In argon at T > 8000°K, the effects of ionization and radiation on sound propagation are investigated. Analyses show how variations of experimental conditions may lead to a determination of radiation properties as well as transport properties at T > 10,000°K. The temperatures were calculated from theoretical temperature–sound velocity relations. The main emphasis of this work is to experimentally determine the acoustic properties of gases at elevated temperatures and to then relate these properties in terms of various relaxation mechanisms including, for example, excited electronic states, ionization, and radiation. For all the gases investigated, the usefulness of ultrasonics to obtain previously unknown quantities is discussed. The strength of ultrasonics as a diagnostic tool is demonstrated and emphasized throughout. (Diss. Abstr.)

10515 SPECTROSCOPIC MEASUREMENTS ON MAGNETICALLY COMPRESSED HIGH-TEMPERATURE PLASMAS. Oertel, Goetz Kuno Heinrich. College Park, Md.; Univ. of Maryland (1963). 72p.

Thesis.

A critical investigation of the applicability of Boltzmann factors and Saha equations to a moving inhomogeneous plasma was carried out. Deviations from LTE are discussed and approximate corrections are presented. Time-resolved spectroscopic measurements in the visible and ultraviolet regions of the spectrum and high-speed photography were performed on the magnetic-compression phase of a preionized plasma with reverse trapped magnetic field in a straight cylindrical single-turn coil. The experimental results are compared with predictions obtained by machine calculations on the basis of a magnetohydrodynamic theory in the two-fluid model. (Diss. Abstr.)

10516 BROADENING AND SHIFT OF CALCIUM LINES BY MICROFIELDS. Kusch, H. J.; Pritschow, H. P. (Univ., Kiel). Astron. Astrophys.; 4: 31-5(Jan 1970). (In German).

Line broadening and shift by microfields of 4 neutral lines and 4 ionic lines of calcium were measured observing side-on the plasma flame protruding from a pulsed discharge through a calcium hydride capillary. Electron density was in the range 1.5×10^{17} cm^{-3} to 4×10^{17} cm^{-3}, the temperature of the plasma was 17,600°K. The results are compared with quantum mechanical calculations as well as with values obtained by the classical

impact approximation and static Stark effect patterns. The agreement is generally good for neutral line widths and less satisfactory for the ionic lines and the shifts. (auth)

Kinetics (General)

Refer also to abstracts 10219, 10495, and 10562.

10517 (N-70-11397) HIGH-FREQUENCY BEAM-PLASMA INTERACTION AT FINITE TEMPERATURES. Seidl, M. (Stanford Univ., Calif. Inst. for Plasma Research). Jun 1969. Contract AT(04-3)-326. 53p. (NASA-CR-106730; SU-IPR-327). CFSTI.

The dispersion equation corresponding to the interaction of an electron beam with a Maxwellian plasma has been solved in quasi-static and infinite-geometry approximations. Two representative beams are considered: a parallel beam with isotropic velocity spread and a helical beam with different longitudinal and transverse temperatures. The aim of the work is to present an experimenter's guide to predict the frequency, growth rate, and wave numbers of the most unstable waves as functions of the basic beam and plasma parameters. The results of the calculations are presented in graphs suitable for comparison with the experiments. The effect of plasma and beam temperatures on the spectrum of the instabilities is discussed in detail. It is shown that the plasma temperature reduces the growth rate of the instabilities of cyclotron harmonic frequencies while a velocity spread in the helical beam suppresses the instabilities everywhere, except in the vicinity of the cyclotron harmonics. (auth) (STAR)

10518 SHOCK WAVES AND RADIATION. Zel'dovich, Ya. B.; Raizer, Yu. P. (Inst. of Applied Mathematics, Moscow. Inst. of Mechanical Problems, Moscow). Ann. Rev. Fluid Mech.; 1: 385-412(1969).

The following topics are discussed: (1) radiant heat exchange and structure of strong shock-wave fronts, (2) radiative phenomena in strong explosions in air, (3) radiant detonation, (4) radiation and relaxation phenomena in shock waves in solids, and (5) light emission by the falling of gas into the surface of a neutron star or a white dwarf. (M.O.W.)

10519 TWO-STREAM ION INSTABILITY IN A PLASMA WITH ION BEAM OF LIMITED CROSS SECTION. Goncharov, A. A.; Kirichenko, G. S. (Inst. of Physics, Kiev). Zh. Tekh. Fiz.; 39: 1979-84(Nov 1969). (In Russian).

It is shown that dispersion properties of the plasma-ion beam system in the low-frequency range depend significantly on the transverse dimensions of the beam. Dispersion equations obtained in the hydrodynamic approximation permit qualitative description of the observed relationship between the frequency and length of the oscillation waves with the beam diameter. The calculations showed that the cylindrical ion beam in plasma can be unstable in a wide range of velocities. However, the maximum oscillations are observed under the conditions in which the wave length is comparable to the diameter of the beam. Such a situation is realized at beam velocities not exceeding the order of ion-acoustic magnitudes. (tr-auth)

10520 INTERACTION OF LASER LIGHT WITH FLUCTUATIONS IN A PLASMA. Polvani, Donald George. New Haven; Yale Univ. (1969). 129p.

Thesis.

A light beam may interact with a plasma by two basic processes, scattering and absorption. Scattering occurs, physically, because of fluctuations about the average electron density. The present work aimed at determining the level of externally driven density fluctuations accompanying the Tonks-Dattner resonances of a cylindrical discharge tube. The experimental method was to measure the light from an argon ion laser scattered in the forward direction by the plasma. Since the scattered light undergoes a well defined frequency shift, a photomixing detection system was employed whereby heterodyning of the scattered and unscattered light occurs in a solid state photodiode. Construction of a low noise microwave receiver (capable of measuring 1.4×10^{-19} watts in a 150 kHz bandwidth) to detect the beat frequency photodiode current resulted in an upper limit for the perturbed density of the main, cold Tonks-Dattner resonance of 1×10^{10} cm^{-3} averaged over a volume 2.4×10^{-4} cm^3 in cross section and 7 cm in length with 150 mw of microwave driving power. A separate theoretical analysis of an absorption process is given for the case of two incident laser beams, whose frequency and wave vector differences, ω, $\underline{k}$ satisfy the plasma dispersion relation. The plasma acts as a mixer to produce a third, transverse or longitudinal, wave of frequency ω and wave vector $\underline{k}$. In steady state, the third wave must absorb energy from the incident beams to balance any dissipation present, thus leading to the determination of transverse and longitudinal absorption coefficients. For incident light fluxes $7 < 5 \times 10^4$ watts/cm^2, absorption by longitudinal waves is the dominant effect even if "absorption" of the forward incident beams by scattering from the induced longitudinal fluctuations is considered. Suggestions for the measurement of the longitudinal coefficient are given. (Diss. Abstr.)

10521 RESONANT BEHAVIOR OF BOUNDED PLASMA. Ignat, David Walter. New Haven; Yale Univ. (1969). 165p.

Thesis.

A plasma column exhibits resonant behavior when excited by an alternating electric field transverse to the column axis. Recent work by Baldwin has provided a prescription for calculating the resonant response in detail for experimentally realistic plasmas and coupling electrode configurations. This thesis develops Baldwin's theory, presents the results of numerical calculations based on it, and reports on experiments designed to analyze the effectiveness of the theory. One of the plasma resonances is a consequence of the singular dielectric behavior of a cold plasma. Agreement between the calculation and experiment are very good for this resonance. The other resonances are related to the ability of a thermal plasma to support propagating longitudinal oscillations. For these resonances, theory and experiment show great qualitative agreement, but quantitative disagreement exists. Possible sources of the discrepancy are discussed and comparison is made with earlier theories which allowed only the calculation of the positions of the latter class of resonances. (Diss. Abstr.)

10522 ROLE OF VOLUME RECOMBINATION IN A DIFFUSION-CONTROLLED, ACTIVE, LABORATORY GAS DISCHARGE PLASMA. Chiplonkar, V. T.; Joshi, S. B. (Inst. of Science, Bombay). Physica; 45: 189-97(24 Nov 1969).

The radial particle distribution profiles were observed by the double-probe method for a cylindrically confined, active plasma. These observations were supplemented by measurements of the decay constants of the plasma at two different radial positions from the axis, when the discharge is quenched. The data were used to evaluate the volume recombination coefficient α and the diffusion coefficients D_e and D_i of the charge carriers. It is shown that volume recombination plays a significant role in determining the distribution profile in the plasma. (auth)

10523 ELECTRICAL CONDUCTIVITY OF SEEDED GASES AT MODERATE TEMPERATURES. Dowdy, Mack Wayne. Atlanta; Georgia Inst. of Tech. (1969). 99p.

Thesis.

The electrical conductivity of an argon-potassium plasma was experimentally determined as a function of current density for gas temperatures of 1500 to 1800°K, gas pressures of 15" Hg vac. and atmospheric, and potassium seeding fractions of 0.002 to 0.004. Electrical conductivities were measured using two different methods. The first was a continuous method in which the voltage-current response of the plasma to a slowly changing applied voltage was recorded on a strip chart recorder. The second was a pulse technique in which the transient voltage-current response of the plasma to a constant-step voltage input was recorded on an oscilloscope. The electrical conductivity theory of Shelton and Carlson was modified to include the effects of argon ionization and radiation loss from the plasma. The experimental data show good agreement with the modified theory and provide electrical conductivity data for higher current densities (~180 A/cm^2) than previously available. The effects of gas pressure and potassium seeding fraction predicted by the theory are verified. The significant peak in electrical conductivity which occurs in the theory of Shelton and Carlson due to the Ramsauer effect of argon tends to become more of a plateau or constant electrical conductivity region in the modified theory because of the importance of argon ionization. The experimental data verify the existence of such a plateau in the electrical conductivity. The modified theory does still predict a peak in electrical conductivity for some test conditions. (Diss. Abstr.)

Kinetics (Experimental)

10524 (AEC-tr-7105) INTERACTION OF A PLASMA BEAM WITH A PLASMA CYLINDER IN THE MAGNETIC FIELD OF DIVERTER. Zykov, V. G.; Karpukhin, V. I.; Rudnev, N. I.; Tolok, V. T. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). Translation of report FTI-167. 9p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 23: 36668. (M.O.W.)

10525 (AEC-tr-7107) MECHANISM OF RESONANCE HEATING OF ELECTRONS IN BEAM-PLASMA DISCHARGE.

Zalesskii, Yu. G.; Nazarov, N. I. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). Translation of report NP-17945. 8p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 23: 36646. (M.O.W.)

10526 (AEC-tr-7112) INVESTIGATION OF THE GROWTH OF AZIMUTHAL CURRENT AND MICROWAVE RADIATION OF A THETA-PINCH PLASMA. Adamov, I. Yu.; Berezhnyi, V. L.; Dushin, L. A.; Kononenko, V. I. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). Translation of report NP-17943. 13p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 23: 36671. (M.O.W.)

10527 ROTATIONAL EFFECTS IN A HIGH-BETA PLASMA CONFINED BY A LONGITUDINAL MAGNETIC FIELD. Stainer, Howard M. (Johns Hopkins Univ., Silver Spring, Md.). Phys. Fluids; 13: 193-202(Jan 1970).

A theoretical study of structured plasma puffs produced in a two-coil theta-pinch gun is presented. The puffs are fired into a drift tube containing a longitudinal magnetic field and their subsequent behavior analyzed. Electron–electron and ion–ion collision times are short enough so that scalar pressures (P = nkT) can be used. Ion–electron collision times, however, are of the duration of the experiment or longer so that the two-fluid moment equations can be employed. An idealized model for the plasma puffs is proposed in which the ion fluid rotates as a rigid body in one direction about the longitudinal axis and the electron fluid rotates in the opposite direction. This high-β model yields self-consistent equilibrium density and magnetic field profiles, stemming from a balance among thermal, magnetic, centrifugal, and electrostatic forces, that are compatible with observation. It is shown that magnetic pick-up loop signals can be analyzed to ascertain the temperature, peak density, angular momentum, etc., of the plasma as it travels down the tube and a sample calculation is presented. The model thereby provides a self-consistent high-β approach to plasma–magnetic field interactions. (auth)

10528 OBSERVATION OF A PLASMA POLARIZATION SHIFT FOR THE RESONANCE LINE OF IONIZED HELIUM. Greig, J. R.; Griem, Hans R.; Jones, L. A.; Oda, T. (Univ. of Maryland, College Park). Phys. Rev. Lett.; 24: 3-5(5 Jan 1970).

The He II 304-Å line emitted from a $N_e \approx 3 \times 10^{17}$-cm^{-3}, $T_e \approx$ 4-eV plasma in a T-type electric shock tube shows a blue shift of ~0.05 Å. This shift is interpreted as due to the negative space charge from the polarization of plasma regions occupied by positive ions. (auth)

10529 SCATTERING AND BEAM TRAPPING IN LASER-PRODUCED PLASMAS IN GASES. Tomlinson, Richard G. (United Aircraft Research Labs., East Hartford, Conn.). IEEE (Inst. Elec. Electron. Eng.), J. Quant. Electron; QE-5: 591-5(Dec 1969).

Experimental evidence is presented to verify that the laser light scattered at 90° from laser-induced breakdown plasmas in air is not due to Thomson scattering from free electrons as has been greatly assumed. The scattering appears to be dominated by reflections from the interfaces of minute localized regions of high electron density. The geometry of the scattering regions indicates that self-focusing may occur in the plasmas generated in some gases. (auth)

10530 ROTATION AND INSTABILITY IN PLASMA JET IMPINGING ON A MAGNETIC FIELD. Kalmykov, A. A.; Trub' chaninov, S. A. (Kharkov Inst. of Physics and Tech.). Zh. Tekh. Fiz.; 39: 1834-44(Oct 1969). (In Russian).

Various effects appearing in plasma jets during interactions with the magnetic barrier fields were studied using coaxial plasma guns that produced high- and low-density jets of various velocities. It was found that a Rayleigh–Taylor type of instability and rotation were developed due to the partial elimination of polarization in low-density fast plasma jets entering into the magnetic barrier field. The slow, high-density jets are long and inhomogeneous along the length. Thus, a more effective short-circuiting of radial polarization takes place which, in turn, eliminates radial electric fields. In the case examined, such short-circuiting acts as a stabilizing factor and prevents instability. (tr-auth)

10531 COOLING OF DENSE DEUTERIUM PLASMA. Goncharova, G. I. Zh. Tekh. Fiz.; 39: 1845-54(Oct 1969). (In Russian).

The initial cooling stages of a strongly ionized plasma generated in a metallic chamber in a strong pulsed discharge at deuterium pressures of 6- to 250-mm Hg ($n_e \approx 10^{16}$ to 10^{19} cm^{-3} and T = 0.9 to 2.6 eV) were analyzed. The results showed that recombination radiation was the basic cooling mechanism in the plasma examined. The rate of cooling of transparent plasma (6 to 80 mm Hg) proved higher than anticipated due to impurities. The reduced initial rate of cooling at given pressure was obviously related to the partial blocking of the emission spectra. (R.V.J.)

10532 EXCITATION AND IONIZATION PROCESSES IN A HELIUM MICROWAVE DISCHARGE PLASMA. Maksimov, A. I. (Inst. of Chemical Physics, Moscow). Zh. Tekh. Fiz.; 39: 1989-96(Nov 1969). (In Russian).

Relative and absolute intensities of spectral lines and ionization frequency in a stationary helium ultrahigh-frequency discharge were measured. Results were correlated with calculated data and the known characteristics of the dc discharge column. (tr-auth)

10533 AN EXPERIMENTAL INVESTIGATION OF THE THERMODYNAMIC STATE OF AN ARGON PLASMA. Marchand, Jean Maurice. Tempe, Ariz.; Arizona State Univ. (1969). 137p.

Thesis.

A free-burning arc was used to generate an argon plasma in the pressure range 0.5 to 3.0 atmospheres. The emission and absorption coefficients of the gas were measured for the 6965 ArI, 7272 ArI, 7635 ArI and 4806 ArII. The continuum emission was also measured at 5535 Å from which the quantum mechanical correction factor was determined. The plasma was found to deviate from complete LTE at pressures below 3.0 atmospheres. At 3.0 atmospheres it was, for all practical purposes, in equilibrium. The cause of the nonequilibrium condition was determined to be an overpopulation of the atom ground state resulting in a lower degree of ionization. The transition probabilities for the argon spectral lines listed above were evaluated accounting for the nonequilibrium condition. The 7272 ArI and 7635 ArI transition probabilities were in excellent agreement with the theoretical results of Garstang, and the value obtained for 4806 ArII was found to be the same as that given by Popenoe and Shumaker. The Debye criteria for determining the ionization potential lowering and the cutoff for the calculation of the partition function are shown to produce dependable results. (Diss. Abstr.)

Kinetics (Theoretical)

10534 (AEC-tr-7113) INTERACTION OF MOVING PLASMA WITH AN OBLIQUE MAGNETIC FIELD. Voytsenya, V. S.; Onishchenko, I. N.; Safronov, B. G. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). Translation of report NP-17664. 14p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 23: 8599. (M.O.W.)

10535 (MATT-749) CONVECTION OF A PLASMA IN A GRAVITATIONAL FIELD. Wobig, Horst (Princeton Univ., N. J. Plasma Physics Lab.). Dec. 1969. Contract AT(30-1)-1238. 33p. Dep. CFSTI.

It is shown that the interchange instability of a magnetoplasma in a gravity field can be stabilized by the combined effect of viscosity and resistivity. There exists a critical R-number R_c below which the plasma layer is stable. $R = (gL/v_{th}^2)\,(L^2B_0^2/\mu_0\eta)$, g = gravity acceleration, μ_0 = viscosity, η = resistivity; B_0 = magnetic field, L = dimension of the layer; v_{th} = thermal velocity. Above this critical R-number R_c the instability leads to a convection, the amplitude of which is calculated by an approximation procedure. It is found that $A \sim \sqrt{R - R_c}$ and the anomalous mass flow $F \sim R - R_c$. (auth)

10536 OPTIMIZATION OF PARTICLE CALCULATIONS IN 2 AND 3 DIMENSIONS. Boris, J. P.; Roberts, K. V. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). J. Comput. Phys.; 4: 552-71(Dec 1969).

A 2-dimensional plasma simulation code, GALAXY, has been developed for the Culham KDF 9 computer to test a number of programming techniques. By treating the coordinates, velocities and accelerations as integers, packing both components in one word, solving the equation of motion in vector form, and coding in optimized assembly language, a factor 2 in storage and a considerable increase in execution speed can be obtained. A triple-buffer technique is used in conjunction with two simultaneous tape transfers on separate channels, in order to make the computer behave as though it had a core store of infinite size, and thus allow a sufficiently large number of particles to be handled on a 32K machine. Coding and timing details are given. Similar techniques are practicable in 3 dimensions, and would enable realistic 3-dimensional plasma calculations to be carried out on existing large computers, but careful consideration must be given to the optimum choice of word length, and to the provision of massive fast backing storage. (auth)

10537 EFFECT OF FOKKER–PLANCK COLLISIONS ON PLASMA WAVE ECHOES. Johnston, George L. (Univ. of California, Los Angeles). Phys. Fluids; 13: 136-9(Jan 1970).

The effect on plasma wave echoes of Coulomb collisions described by a complete Fokker–Planck collision term is determined theoretically by application, in first and second orders, of the particular integral of a linearized kinetic equation which is capable of describing a Fokker–Planck collisional kinetic equation in the resonant region. (auth)

10538 REVERSE CURRENT INDUCED BY INJECTION OF A RELATIVISTIC ELECTRON BEAM INTO A PINCHED PLASMA. Cox, James L. Jr.; Bennett, Willard H. (North Carolina State Univ., Raleigh). Phys. Fluids; 13: 182-92 (Jan 1970).

A macroscopic treatment of the current induced in a dense pinched plasma because of its penetration by a relativistic electron beam of finite length is presented. The behavior of the plasma is described by the generalized Ohm's law which takes account of the inertia of the plasma electrons in addition to collisions between the plasma electrons and ions. Under some conditions, the current density induced in the plasma is found to contain both longitudinal and transverse (radial) plasma oscillations. The total induced current flowing in the axial direction due to an injected pulse which varies slowly during times on the order of magnitude of the time in which the plasma can respond significantly to the beam disturbances is also calculated and investigated for the following three cases: (1) $\nu_m \ll \omega_p$, (2) $\nu_m \sim 2\omega_p$, and (3) $\nu_m \gg \omega_p$, where ν_m is the frequency of momentum transfer collisions between plasma electrons and ions and ω_p is the electron plasma frequency of the plasma electrons. In case 1, it is found that the induced current is nearly equal in magnitude and opposite in direction to the beam current and that it lies almost entirely within the beam channel over the entire length of the beam pulse. These conclusions are consistent with the results of some recently reported experiments which satisfy the conditions of case 1. The induced current in case 1 also contains an oscillatory component with a frequency near the plasma frequency of the plasma electrons. This contribution to the induced current is not significant for the experiments considered, and this conclusion is also consistent with observation. The results of case 3 are equivalent to the results obtained by treating the plasma as a simple Ohmic medium. (auth)

10539 COUPLED-MODE DESCRIPTION OF BEAM–PLASMA INTERACTION. Ho, Bong (Michigan State Univ., East Lansing). Electron. Lett.; 5: 719-20(Dec 1969).

A coupled-mode method is used to analyze the interaction between the slow space-charge wave of an electron beam and the electroacoustic wave of a lossless warm plasma. A transmission-line analogue of the plasma electroacoustic wave is developed. Maximum gain expression is obtained from the solution of the beam–plasma coupled-mode equations. (auth) (UK)

10540 COLLISIONAL EFFECT ON THE QUASILINEAR PROCESS ASSOCIATED WITH THE ION-WAVE INSTABILITY. Nishikawa, K. (California Inst. of Tech., Pasadena). Contract NAS 7-100. Phys. Lett.; 30A: 537-8(29 Dec 1969).

Using a simple model it is shown that the quasi-linear feedback effect of enhanced ion-wave fluctuations on the average electron, distribution in a current-carrying plasma is negligible as far as collisions can effectively prevent oscillation of trapped electrons. (auth)

10541 POSSIBLE MECHANISM OF FAST-PARTICLE GENERATION IN ELECTRODYNAMIC PLASMA ACCELERATORS. Khizhnyak, N. A. (Kharkov Inst. of Physics and Tech.). Zh. Tekh. Fiz.; 39: 2040-53(Nov 1969). (In Russian).

The structure of the field polarization potential in plasma entrained during the process of the current front acceleration was studied. It is shown that the output of such a front at the end of the gas distribution induced intense polarization oscillations, which were responsible for the appearance of fast particles. Current exit at the end of the rail accelerator was studied and the flow into the vacuum of plasma with magnetized electrons was analyzed using the approximation of two-fluid hydrodynamics. The given theory describes qualitatively (and according to the total number of particles in the fast cluster and its mean velocity, quantitatively) the regularities previously uncovered by an experimental method. The system of integro–differential equations describing the energy spectra of ions in a fast cluster was obtained. (tr-auth)

10542 APPROXIMATE METHODS OF CALCULATIONS OF EQUILIBRIUM IONIZED COMPONENTS OF INERT-GAS PLASMA. Sinitsyu, N. V. Zh. Tekh. Fiz.; 39: 1911-13(Oct 1969). (In Russian).

Equilibrium ionized components of inert gas plasma were calculated by a method developed on the basis of the linear approximation of electron concentration as an exact function of temperature, calculated with the consideration of Coulomb interactions. The obtained approximation is expressed as $n_e = \alpha(T - T_0)\rho/A$, where α and T are constants of the T and ρ data; T is the temperature, ρ is plasma density, A is the atomic weight. Tabulated data on the α and T_0 coefficients for argon, neon, krypton, and xenon gases showed that the order of error in determining n_e did not exceed 10%, starting with the magnitudes of $n_e \geq 1.7\,\rho/A$. (R.V.J.)

10543 INFLUENCE OF ION–ACOUSTIC INSTABILITY ON THE SKIN EFFECT IN PLASMA. Breizman, B. N.; Mirnov, V. V.; Ryutov, D. D. Zh. Tekh. Fiz.; 39: 1817-21(Oct 1969). (In Russian).

The skin effect in an intense high-frequency field in plasma was studied, considering the case in which the hf amplitude is so large that the electron current velocity in the skin layer reached the critical point corresponding to the excitation threshold of ion–acoustic instability. It is shown that the instability leads to considerable increase of the skin-layer thickness. (tr-auth)

10544 COMPENSATION OF TOROIDAL DRIFT OF PARTICLES BY MEANS OF A ROTATIONAL MAGNETIC FIELD. Soldatenkov, T. R. (Sukhumi Inst. of Physics and Tech., USSR). Zh. Tekh. Fiz.; 39: 1803-9(Oct 1969). (In Russian).

Particle drift motion in a toroidal magnetic field becomes finite in cases of superimposed rotational magnetic fields. The particle trajectories display a circumference with a center shifted in relation to the torus axis $r = R$ to the magnitude $\Delta r = \rho^2/R$ (ρ is the Larmor radius of the particle in an alternating magnetic field $\vec{H}$). The shift of the particles is significantly influenced by a constant transverse magnetic field H_1. At $H_1 \approx \vec{H}$, the shift is comparable to the transverse dimensions of the system. (tr-auth)

10545 EFFECTS OF NONLINEAR MONOCHROMATIC WAVE ON ELECTRIC CONDUCTIVITY OF COMPLETELY IONIZED PLASMA. Baimbetov, F.; Tsintsadze, N. L. (Tbilisi State Univ., USSR). Zh. Tekh. Fiz.; 39: 1781-5(Oct 1969). (In Russian).

The influence of nonlinear monochromatic ion–acoustic waves of finite amplitude on the electric conductivity of completely ionized plasma was investigated. It is shown that the presence of such a wave results in reduced electric conductivity of plasma. (tr-auth)

10546 STUDIES OF SHOCK WAVE STRUCTURE IN BINARY MIXTURES. Pataraya, A. D. (Tbilisi Inst. of Physics, USSR). Zh. Tekh. Fiz.; 39: 1770-3(Oct 1969). (In Russian).

Shock wave structure in binary mixtures was studied by means of normalized Mott–Smith functions. Equations were obtained for the width of the shock wave and for the mixture of Ar–He, and the width magnitude was compared with the results obtained by W. H. Andersen et al. (Phys. Fluids, 4: 650(1961)). Formulas for gas mixture temperatures were also obtained. (tr-auth)

10547 INFLUENCE OF IONIZATION OF NEUTRAL GAS AND ION RECOMBINATION ON ELECTRODYNAMIC ACCELERATION OF PLASMA. Kolesnikov, P. M. Zh. Tekh. Fiz.; 39: 1750-5(Oct 1969). (In Russian).

The influence of ionization and recombination processes on electrodynamic acceleration of plasma in coaxial or rail-type accelerators is studied. Numerical solutions are obtained for corresponding differential equations and analyses are given of their solutions. (tr-auth)

10548 SOLUTION OF A SPATIALLY DEPENDENT FOKKER–PLANCK EQUATION FOR MIRROR-CONFINED PLASMAS. Marx, Kenneth Donald. Davis, Calif.; Univ. of California (1968). 142p.

Thesis.

The Fokker–Planck equation for a plasma is applied to particle distributions that are characterized by the velocity space loss cone inherent to mirror confinement systems. When cast in the form of a partial differential equation whose independent variables are time, magnitude of velocity, and the angle between the velocity and the magnetic field, the Fokker–Planck operator has the form of a parabolic equation. As such, the equation lends itself to solution by the Peaceman–Rachford method, a technique that utilizes implicit differencing in alternating directions. The prototype problem to which these techniques is applied is that of building up a particle distribution in a mirror device by injecting a current of particles. This corresponds to a situation such as exists in the ALICE experiment. Some problems are also solved in which a distribution is assumed initially present, and the loss rates and relaxation of the distribution functions are calculated. This type of problem is modeled after experiments such as 2-X. (Diss. Abstr.)

10549 COLLISIONAL RADIATIVE RECOMBINATION IN HYDROGEN PLASMAS AND IN ALKALI PLASMAS. Curry, Bill P. (Univ. of California, Livermore). Phys. Rev., A; 1: 166-76 (Jan 1970).

A simplified variational model for collision-dominated recombination of atomic ions is presented. The results are analytical formulas for electron–electron–ion recombination coefficients applicable to atomic systems whose outer electrons conform to one-electron energy-level structure. When combined with radiative transition probabilities, these results yield collisional-radiative recombination coefficients which are then compared with other theories and available experimental studies. In particular, fair agreement is found with Norcross and Stone's elaborate calculations for cesium recombination. (auth)

10550 ELECTRON DISTRIBUTION FUNCTIONS IN WEAKLY IONIZED PLASMAS. Bernstein, Ira B. (Yale Univ., New Haven). Contract AT(30-1)-1238. Advan. Plasma Phys.; 3: 127-56(1969).

The electron–neutral collision integral is expanded in powers, effectively, of m/m' (m is mass of electron, m′ is mass of heavy particle). This result is adapted to an expansion of the electron distribution function in powers of the characteristic small parameter $\epsilon = eE\tau/mv + v\tau/L$, where E is the electric field, τ the appropriate mean free time between collisions, v the speed under consideration, and L the macroscopic characteristic length. It is shown that m/m' must be treated as of order ϵ^2. Various properties of the equation governing f_0, the lowest significant order part of the electron distribution function, which is isotropic in the velocity variable v, are derived. The boundary condition on f_0 at a wall is derived, given that on the unexpanded electron distribution function f. The notions previously exploited are used to extend the theory to include harmonically time-varying fields. A brief discussion is given of inelastic collisions, ionizing collisions, and charged-particle encounters. Also, a uniform treatment which encompasses both the theory here developed and the Chapman–Enskog method is sketched. (M.O.W.)

10551 CLASSICAL PLASMA PHENOMENA FROM A QUANTUM MECHANICAL VIEWPOINT. Harris, E. G. (Univ. of Tennessee, Knoxville. Oak Ridge National Lab., Tenn.). Contract AT(40-1)-2598. Advan. Plasma Phys.; 3: 157-241(1969).

The following topics are discussed: (1) the dielectric tensor and wave propagation, (2) quantization of the electromagnetic field in a dispersive medium, (3) quasi-linear theory, (4) scattering of particles and photons by plasmas, (5) nondivergent kinetic equations, (6) higher-order processes, and (7) interaction of monochromatic waves. (M.O.W.)

10552 PHOTON BREMSSTRAHLUNG FROM AN EXTREME RELATIVISTIC HYDROGEN PLASMA. Kvasnica, J. (Charles Univ., Prague). Czech. J. Phys.; 19: 1533-9(1969).

The effect of the electron–positron pair creation on the intensity of radiation by an extreme-relativistic plasma is studied. The degeneracy of the electron and positron gases is taken into account. It is found that the pair creation is of considerable importance for both the quantity and temperature dependence of the radiation intensity. (auth)

10553 SHORT-RANGE CORRECTIONS TO THE PROPABILITY DISTRIBUTIONS OF THE ELECTRIC MICROFILED IN A PLASMA. Dalenoort, G. J. (EURATOM–FOM, Jutphaas, Netherlands). Physica; 45: 283-304(24 Nov 1969).

The modification, which Gans introduced to correct the Holtsmark distribution for the electric microfield in a plasma for short-range effects, is extended to include general weight functions (Gans introduced a cutoff for short distances). The result of Gans is critically analyzed and evaluated numerically, using a computer. This is done at two stages: first for the expression which has not yet been approximated for numerical evaluation and secondly for the approximated but modified result. Then the result of Jackson and Klein, using the continuum model is compared to the results in the Holtsmark–Gans model, and a qualitative explanation is given for the agreement. Finally, the correction, according to Gans, is applied to time-dependent distributions, recently derived by the author, and numerical results are given for the corresponding time-dependent correlation functions. (auth)

10554 CONVERGENT KINETIC EQUATION FOR PLASMA IN MAGNETIC FIELD. Schram, P. P. J. M. (Univ. of Rochester, N. Y.). Physica; 45: 165-88(24 Nov 1969).

A Boltzmann-type kinetic equation is derived for a homogeneous electron plasma in a strong uniform magnetic field. The relaxation to thermal equilibrium is described by a convergent collision integral, although shielding is neglected. It is shown that the impulse approximation leads to a modification of the kinetic equation derived earlier by Rostoker and others. Also a quantum-mechanical kinetic equation is derived in the weak-coupling approximation. Its relation to the classical equations is discussed. (auth)

Production

Refer also to abstract 10509.

10555 (UCRL-Trans-10424) PRODUCTION OF HYDROGEN PLASMA BY GIANT PULSE LASERS. A THEORETICAL STUDY. Mulser, P. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Translated by L. B. Kapp for Univ. of California, Lawrence Radiation Lab., Livermore, from report IPP-3/95. 55p. Dep. CFSTI.

The problem of interaction of an intense laser beam with solid hydrogen is theoretically investigated in a one-dimensional plane geometry. The time-dependent distributions of density, temperature, and velocity of the produced plasma, as well as those of the solid, are found by numerical solution of the hydrodynamic equations for various laser powers. The maximum temperature can be expressed approximately in closed form as a function of the laser intensity and time. The calculations allow for the influence of thermal conduction and viscosity. At laser intensities above 1.8×10^{11} W/cm^2 the frequency of the plasma rises above that of the laser in the transition sheath between the hot plasma and the cold solid compressed in the ratio 1:4. The problem of the absorption and reflection of laser radiation in this region is investigated. (auth)

10556 APPARATUS FOR PLASMA PRODUCTION AND INTERACTION. Consoli, Terenzio; Legardeur, Rene; Slama, Lucien (to Commissariat a l'Energie Atomique). British Patent 1,177,171. 7 Jan 1970. Priority date 11 Mar 1966, France.

An apparatus is described which, using a combination of electric and magnetic fields, produces beams of plasma and causes them to interact, these beams being of high intensity and composed of high-energy ions and electrons. (M.O.W.)

10557 OBTAINING HIGH TEMPERATURES AND STRONG MAGNETIC FIELDS IN A LASER PLASMA PRODUCED BY A TUBULAR LIGHT BEAM. Askar'yan, G. A. (Lebedev Inst. of Physics, Moscow). JETP Lett. (USSR) (Engl. Transl.); 10: 250-1(20 Oct 1969).

Translated from Zh. Eksp. Teor. Fiz. Pis'ma Redaktsiyu; 10: 392-4(20 Oct 1969).

The plasma of a light spark or a flare, produced by a focused tubular light beam (the hole in the center and the sharp edges can be produced in simple fashion by using a small screen) was studied. If the geometry is assumed to be quasi-cylindrical, then the amplitude of the converging shock wave is $p \sim \gamma^{-b}$, where $b = 2(1 - a)/a$ depends on the adiabatic exponent of the medium and on the geometry. The increase in temperature and magnetic fields is discussed. (auth)

10558 MECHANISMS FOR PRODUCTION OF NEUTRON-EMITTING PLASMA BY SUBNANOSECOND LASER-PULSE HEATING. Shearer, J. W.; Barnes, W. S. (Univ. of California, Livermore). Phys. Rev. Lett.; 24: 92-4(19 Jan 1970).

One-dimensional numerical calculations were made of the heating of a thick target of solid-density deuterium by focused subnanosecond pulses of neodymium-glass laser light. The conditions for neutron emission were found to be produced by two different mechanisms. The results are found to be in semiquantitative agreement with recent experimental results. (auth)

10559 A STUDY OF ELECTRON BEAM COLLECTOR WITH IONIZATION CAVITY. Ishii, Shigeyuki; Miyoshi, Syoichi; Okamoto, Konsuke (Inst. of Physical and Chemical Research, Tokyo). Jap. J. Appl. Phys.; 8: 1351(Nov 1969).

A method is presented for producing the second state of electron-beam-generated plasma, to be used in triggering the third-state plasma. It is shown that the second state (high-density, weak hard x radiation) is produced if the He gas is supplied to the ionization cavity, but not if the gas is fed directly into the vessel. (D.L.C.)

10560 OBSERVATION OF NEUTRONS PRODUCED BY LASER IRRADIATION OF LITHIUM DEUTERIDE. Gobeli, G. W.; Bushnell, J. C.; Peercy, P. S.; Jones, E. D. (Sandia Labs., Albuquerque, N. Mex.). Phys. Rev.; 188: 300-2(5 Dec 1969).

The observation of neutrons produced by irradiation of polycrystalline LiD targets with a high-power laser is reported. Single pulses from a mode-locked Nd^{+3}-doped glass laser were amplified up to energies of 25 J. Pulse widths were 2 to 3 psec as measured by the two-photon fluorescence technique. The analyses of these experiments yield a somewhat higher rate of neutron production than the similar experiments recently reported by Basov et al. (auth)

Stability

Refer also to abstracts 10519, 10582, and 10583.

10561 (N-70-10027) ABSOLUTE AND CONVECTIVE MICROINSTABILITIES OF A MAGNETIZED PLASMA. Callen, James D.

(Massachusetts Inst. of Tech., Cambridge. Center for Space Research). Apr. 1968. 509p. (NASA-CR-94641; CSR-T-68-3). CFSTI.

Thesis.

The electrostatic instabilities of a low-beta, weakly inhomogeneous, hot, fully ionized collisionless plasma in a magnetic field are considered. Some discussion is given of the values of beta for which only electrostatic modes need be considered, of the restrictions imposed by equilibrium considerations on any magnetic field curvature which may be present, and of the local approximation to the integro-differential dispersion equation. Rigorous necessary and sufficient conditions for instability of the plasma are derived. These conditions extend those previously available for homogeneous plasmas to weakly inhomogeneous plasmas and, in general, justify and elucidate the commonly used marginal stability analysis. The problem of distinguishing between convective and absolute instabilities is reviewed. A new and very efficient method for determining the density at which an absolute instability of the plasma has any given temporal growth rate, including zero, is developed. (auth) (STAR)

10562 HEAT TRANSFER IN PLASMA DUE TO INSTABILITY AT LOCKED-IN ELECTRONS. Kadomtsev, B. B.; Pogutse, O. P. Dokl. Akad. Nauk SSSR; 188: 311-14(11 Sep 1969). (In Russian).

Following up the authors' previous studies on drift waves, the effect of electric trapping of particles in the drift waves is examined further on an axially symmetric Tokamak system. An expression is derived for the coefficient of electron temperature conductivity of trapped electrons. For strong collisions when a turbulent convection is generated, it may be expected that the diffusion coefficient D will be similar to the temperature conductivity coefficient χ. In the case of laminar convection, in the approximation method used, D is equal to zero, but if the magnetic drift is taken into account, the diffusion will be $D \sim a/R\,\chi$, whereby a is the small radius of the plasma torus and R is the radius of curvature of the magnetic axis. (TTT)

10563 NEGATIVE MASS INSTABILITIES. Callen, J. D.; Horton, C. W. (Inst. for Advanced Study, Princeton, N. J.). Phys. Fluids; 13: 154-65(Jan 1970).

Previous studies of negative mass instabilities are extended for particles that do not encircle the axis of symmetry, to include the effects of thermal spreading in the ion velocity distribution, particle drifts, a new finite ion Larmor radius effect due to radial variations in the magnetic field B, and particle mirroring (bounce effects). For large anisotropies ($T_\perp \gg T_\parallel$) thermal spreading of the velocity distribution is found to introduce a low-density threshold and often to remove the cutoff of the instabilities at high densities. A (radial) min-B configuration is found to have a stabilizing effect on the longest (azimuthal) wavelength modes. Also, stabilization of the fastest growing modes is predicted if the velocity distribution is reasonably isotropic: $T_\parallel/T_\perp \gtrsim 4a_i/L$ (a_i is the ion Larmor radius, L is the scale length of magnetic field variation). (auth)

10564 COMPRESSIBLE RESISTIVE TEARING INSTABILITY IN THE HARD-CORE PINCH. Lister, G. G.; Hosking, R. J. (Flinders Univ. of South Australia, Bedford Park). Phys. Fluids; 13: 144-8(Jan 1970).

The influence of compressibility on the real growth rates of the resistive "tearing" instability in the hard-core pinch is considered. Numerical calculations indicate that the growth rates differ little for the chosen physical parameters from those given by incompressible theory. The difference is considerably less than an order of magnitude. Inclusion of terms involving the perturbed field in the direction of the field is found to have the most noticeable stabilizing effect particularly when the ratio of azimuthal to axial field in increased. In many cases, the high m modes are found to be the more unstable. (auth)

10565 REMOTE FEEDBACK STABILIZATION OF COLLISIONAL DRIFT INSTABILITY BY MODULATED MICROWAVE ENERGY SOURCE. Hendel, H. W.; Chu, T. K.; Perkins, F. W.; Simonen, T. C. (Princeton Univ., N. J.). Phys. Rev. Lett.; 24: 90-2(19 Jan 1970).

The collisional drift instability is remotely feedback-stabilized by irradiating the plasma with microwaves to heat the electrons locally, by upper-hybrid resonance absorption, at interior plasma locations. The phase and amplitude of the feedback-modulated heating necessary for stabilization agree qualitatively with a linear theory, which includes a feedback-controlled heat source. (auth)

10566 STRONG-CURRENT PULSED ARC IN HYDROGEN AT PRESSURE OF 400 atm. Petrenko, V. I.; Mitin, R. V.; Knyazev, Yu. R.; Zvyagintsev, A. V. (Kharkov Inst. of Physics and Tech.). Zh. Tekh. Fiz.; 39: 1827-33(Oct 1969). (In Russian).

Experimental studies were made of a pulsed arc in hydrogen at 400-atm pressure, arc length up to 20 mm, 60- to 70-kA currents, and pulse length ~0.6 msec. It is shown that at large pressures and arc lengths the pulsed discharge in hydrogen is unstable. The pulse discharge plasma parameters were evaluated. (tr-auth)

10567 NONLINEAR THEORY OF HYDRODYNAMIC BEAM INSTABILITY. II. Makhan'kov, V. G.; Shchinov, B. G. (Joint Inst. for Nuclear Research, Dubna, USSR). Zh. Tekh. Fiz.; 39: 1795-8(Oct 1969). (In Russian).

Effects of non-linear interactions of harmonics on quasi-linear relaxation of aperiodic beam instability were estimated. (tr-auth)

10568 INSTABILITY OF HOMOGENEOUS PLASMA WITH CURRENT. Aref'ev, V. I. Zh. Tekh. Fiz.; 39: 1973-8(Nov 1969). (In Russian).

Conditions conducive to the appearance of plasma instabilities in the presence of a current component perpendicular to the magnetic field were investigated. Studies were confined to the high-frequency region of instability oscillations in which the ions were not magnetized ($\omega_{Hi} \ll \omega_{He}$). The instability boundary was determined as a function of a series of parameters distributed at the ion-acoustic level. In the case of hot ions, the most unstable were the oscillations of the electron acoustic type with a low excitation level $(T_i/M)^{1/2}(m/M)^{1/4}$. The region of the transition of kinetic instability into hydrodynamic instability is also studied. (tr-auth)

10569 STABILITY OF ROTATING THETA-PINCH PLASMA. Palsedge, John Armit. Salt Lake City; Univ. of Utah (1969). 94p.

Thesis.

The kink instability of an infinitely long cylindrical plasma of radius a has been examined. The plasma was assumed to have the parameters of a theta pinch of the Scylla type, with density of 10^{16} ions-cm^{-3}, ion temperature of 3 keV, and electron temperature of 300 eV. The bounce model was used to represent the plasma. The interior of the plasma, containing zero magnetic field, was assumed to be separated from the external field by a thin sheath from which the particles "bounce" symmetrically. The "rigid rotor" solution of the Boltzmann-Vlasov equation was chosen as the initial distribution function, which represents an isotropic Maxwellian plasma rotating with a constant angular velocity ω. (Net plasma rotation has been observed in several experiments.) The plasma radius was assumed to be perturbed an amount $\epsilon = \epsilon_0 \cos m\,\theta \cos kz$ with m = 1, and the change in pressure at the plasma-magnetic field boundary determined. This pressure has three components, which are the pressure due to the unperturbed plasma acting on the perturbed plasma surface, the pressure due to the perturbed plasma acting on the unperturbed surface, and the perturbed magnetic pressure. Calculating the second of these required solving the Boltzmann-Vlasov equations by the method of characteristics. The perturbed magnetic pressure was found by solving the appropriate magnetic scalar potential boundary value problem. Since any "centrifugal force" effects are proportional to the square of the angular velocity, the calculations were carried to second order in the quantity ($\omega a/v$), where v is the ion thermal velocity. Results of the calculations showed that for perturbations having short wavelengths, the perturbation rotates with the plasma ions, while for longer wavelengths the perturbation rotates more slowly. The growth rate is a function of rotational velocity and wavelength with an exponential growth time τ of 25 μsec for typical values of plasma parameters. The growth time lies between the result obtained for the magnetohydrodynamic model of infinite growth time (stability) and the rigid body limit where $\tau = 1/\omega$. Conservation of angular momentum shows that the perturbation amplitude is bounded, and the perturbed plasma does not strike the compression coil. This instability should appear in the proposed 15 meter long Pre-Scyllac theta pinch, but it should not have a serious effect on plasma containment. (Diss. Abstr.)

10570 STABILITY OF PLASMA AGAINST INTERCHANGES IN GENERAL MAGNETIC FIELD. Lacina, J. (Inst. of Plasma Physics, Prague). Czech. J. Phys.; 19: 1614-15(1969).

In an earlier paper (Lacina, Czech. J. Phys., B19: 1301(1969)), necessary and sufficient energy criteria for plasma stability against perturbations preserving two constants of motion were derived. It was shown that those criteria held both exactly and generally for any kind of collisionless low-β plasma. As is well known, interchanges are perturbations arising at low β and preserving the magnetic moment and the longitudinal invariant. Thus, one can use the mentioned criteria for the examination of plasma stability against these perturbations. Due to the exactness of these criteria, new results are obtained in comparison with those ob-

tained by an intuitive use of energy principle. The plasma considered is confined by a general magnetic field in which all particle drift orbits are closed. Axisymmetric mirror fields, Ioffe stabilized mirror fields, and some toroidal fields are of this type. (M.O.W.)

Thermonuclear Processes

Refer also to abstracts 9708, 10363, 10558, and 10891.

10571 (MATT-658) SYNCHROTRON RADIATION FROM FUSION REACTORS. Mills, R. G. (Princeton Univ., N. J. Plasma Physics Lab.). Dec 1969. Contract AT(30-1)-1238. 26p. Dep. CFSTI.

Early studies of synchrotron radiation in plasmas concentrated on hypothetical D-D reactors in which the synchrotron radiation losses would be quite severe. Losses from an assumed D-T plasma are far less. Nevertheless, they could become important in machines where β must be small. There exist critical radii and critical β's below which radiation losses would exceed the fusion energy released to charged particles within the plasma from fusion reactions. An economic reactor should operate with conditions exceeding these levels. For D-T, if the electron temperature is less than 50 kV and the plasma radius is greater than 100 cm, the critical β is less than 0.01. For most plasma conditions postulated for thermonuclear reactors, the synchrotron radiation will be less than bremsstrahlung. (auth)

10572 (MATT-735) SPHERATOR AND RELATED EXPERIMENTS. Yoshikawa, S. (Princeton Univ., N. J. Plasma Physics Lab.). Dec 1969. Contract AT(30-1)-1238. 31p. (CONF-690931-2). Dep. CFSTI.

From International Symposium on Closed Confinement Systems, Dubna, USSR.

A review of spherator experiments at Princeton and the summary of the present hypothesis in regard to plasma loss across the magnetic field were discussed. A schematic diagram of the spherator is shown. Three main coils are required. The internal ring provides the poloidal magnetic field. The resulting field pattern has magnetic surfaces, and one expects it to have both a minimum-average-B configuration and a high shear. The plasma is made around the center conductor. By inserting a probe from the outside, one expects to find that the density peaks and then goes to zero as it reaches the center conductor. (auth)

10573 INFLUENCE OF TOROIDALTY ON THE STELLARATOR MAGNETIC SURFACES. Danilkin, I. S.; Karpenko, I. K. (Moscow Inst. of Physics). Zh. Tekh. Fiz.; 39: 1959-72(Nov 1969). (In Russian).

Magnetic surfaces of two-inlet stellarator were studied, taking into account the corrections for the curvature k in the system. In contrast to the previously published data, the development is carried out in a wider range area of magnetic axis system, whose position depends on the current distribution in the helical winding of the stellarator and must be determined by means of the exact solution for the magnetic field potential. Data obtained enabled the magnetic surfaces of the pre-axis region to be more precisely described, and the qualitative variations of their topology in the peripheral region to be examined (the region of separatrix of the initial system with k = 0). (tr-auth)

Wave Phenomena

Refer also to abstracts 10514, 10537, 10540, and 10545.

10574 (AD-694693) INVESTIGATION OF HARMONIC ION CYCLOTRON WAVE PROPAGATION AND DAMPING IN A PLASMA. Dodge, N. B.; Melton, J. G.; Friedrich, O. M. Jr.; Dougal, A. A. (Texas Univ., Austin. Electronics Research Center). 1969. Contract NSG-353. 10p. (AFOSR-69-2517-TR). CFSTI.

Propagation, damping, power coupling, and plasma heating characteristics of harmonic ion cyclotron waves are discussed. Power coupling and plasma heating are found to decrease with increasing harmonic wave number. Plasma temperature is the dominant parameter which determines conditions for propagation of the harmonic waves. Efficiencies of plasma heating for the various harmonics is presented. (auth)(USGRDR)

10575 (MATT-743) GENERATION OF HIGH-FREQUENCY NOISE AND ION PLASMA OSCILLATIONS WITH LANGMUIR PROBE IN A MAGNETICALLY CONFINED PLASMA. Fujita, Junji (Princeton Univ., N. J. Plasma Physics Lab.). Dec 1969. Contract AT(30-1)-1238. 35p. Dep. CFSTI.

High-frequency noise (40 to 500 MHz) was found to be generated by the electron current to a Langmuir probe in a plasma of Etude Stellarator when the probe bias is above some critical voltage. This point is close to the space potential determined from probe characteristics. The frequency spectrum of this noise during discharge pulse is broad and has an upper limit around ω_{pi}, while the noise observed in the afterglow plasma lies at clearly defined frequencies close to ω_{pi} and its higher harmonics (~5 ω_{pi}). Oscillations are well described on the basis of the excitation of the ion waves by the probe current itself. The observation of the onset of this noise or the frequencies of the noise generated in an afterglow may be useful for finding out either space potential or the exact decay of local plasma density. (auth)

10576 THE OBSERVATION OF COUPLING BETWEEN LOW- AND HIGH-FREQUENCY RESONANCES IN A BOUNDED PLASMA. Asmussen, Jes Jr.; Lee, Quong H. (Michigan State Univ., East Lansing). Proc. IEEE (Inst. Elec. Electron. Eng.); 57: 2151-2(Dec 1969).

The coupling between low- and high-frequency resonances of a plasma capacitor is discussed. A low-frequency ion oscillation is found to cause the zero-order density profile to vary at ω_i. This variation of the density profile causes the third-harmonic output of the capacitor to be frequency-modulated. (auth)

10577 PERTURBATION METHOD FOR A NONLINEAR WAVE MODULATION. II. Asano, Naruyoshi (Nagoya Univ., Japan); Taniuti, Tosiya; Yajima, Nobuo. J. Math. Phys. (N. Y.); 10: 2020-3(Nov 1969).

A perturbation method given in a previous paper of this series is applied to two physical examples, the electron plasma wave and a nonlinear Klein-Gordon equation. In these systems, and probably in most physical systems, an assumed condition for a mode of $l = 0$ is not valid. Consequently, the direct application of the method is impossible. It is shown by these examples how this difficulty can be overcome to allow one to use the method. As a result it was found that, in either case, the original equation can be reduced to the nonlinear Schroedinger equation. (auth)

10578 PHYSICAL MODEL OF CYCLOTRON DAMPING. Lutomirski, R. F. (Rand Corp., Santa Monica, Calif.). Phys. Fluids; 13: 149-53(Jan 1970).

A plasma with a prescribed zero-order distribution function, imbedded in a uniform magnetic field, is assumed to be perturbed by an electromagnetic wave propagating parallel to the field. For small-amplitude waves (i.e., a whistler wave), the interaction between the wave and the plasma is computed directly from the single-particle equations of motion. The method readily reveals which particles dominate the interaction and yields insight into the damping mechanism. In contrast to conventional treatments of the problem via the Vlasov equation, the period of time one must wait for the asymptotic forms to be valid is readily obtained by the present method. (auth)

10579 OSCILLATIONS OF A WEAKLY INHOMOGENEOUS PLASMA. Bajwa, G. S.; Srivastava, K. M. (Univ. of Jodhpur, India). Phys. Fluids; 13: 117-20(Jan 1970).

An attempt has been made to study the oscillations of a collisionless, incompressible plasma, immersed in a weakly inhomogeneous magnetic field. Analysis is based on the use of an orthogonal curvilinear coordinate system. It is found that for $\omega \ll \omega_{ci}$, radio signals will suffer least-possible attenuation when $k \gg 0.53146 \times 10^{-4}\ T^2$, where ω_{ci} is the ion cyclotron frequency, k is the wave vector perpendicular to both the magnetic field and its gradient, and T is the kinetic temperature. Discussions are also extended to the complex frequencies, and expressions for resonance, as well as for cutoff frequencies, are derived. (auth)

10580 MODE CONVERSION IN A WEAKLY INHOMOGENEOUS COLLISIONLESS MAGNETOPLASMA. Tang, Ting-wei (Univ. of Massachusetts, Amherst). Phys. Fluids; 13: 1235 (Jan 1970).

The propagation of an extraordinary wave in a weakly inhomogeneous collisionless magnetoplasma is first studied in the cold plasma approximation. As the cold plasma theory breaks down near the upper hybrid resonance, a fourth-order warm plasma field equation is derived and its solutions obtained in integral form. Connection formulas based on the asymptotic expansion of the integral solutions by the method of saddle-point integration are deduced. These connection formulas are then applied to the problem of mode conversion between extraordinary waves and electrostatic plasma waves across the upper hybrid resonance. (auth)

10581 SINGLE-INTEGRAL FORM OF THE DISPERSION RELATION FOR WAVES IN A MAGNETIZED PLASMA. Catto, Peter J.; Baldwin, David E. (Yale Univ., New Haven). Phys. Fluids; 13: 214-(Jan 1970).

The dispersion relation for waves in a uniform magnetized plasma is written in a single integral representation. This form

should be useful in numerical applications. Examples of model loss-cone and temperature anisotropy distributions are treated. (auth)

10582 INSTABILITY OF OSCILLATIONS WITH FREQUENCY EQUAL TO HALF THE ION-CYCLOTRON FREQUENCY. Timofeev, A. V. JETP Lett. (USSR) (Engl. Transl.); 10: 247-9(20 Oct 1969).

Translated from Zh. Eksp. Teor. Fiz. Pis'ma Redaktsiyu; 10: 389-92(20 Oct 1969).

Asymptotic methods developed in the theory of the nonlinear oscillator were used in the analysis of the evolution of the oscillations with $\omega = \omega_i/2$. It is noted that the parametric buildup of oscillations can be regarded as a particular case of decay instability. (M.O.W.)

10583 LANDAU SINGULARITIES FOR A DOUBLE-STREAM INSTABILITY PLASMA. Braun, J. C. (Laboratoire de Physique des Milieux Ionises, Nancy). Phys. Lett.; 30A: 504-5(29 Dec 1969).

Dispersion relation roots in a double-stream instability plasma are given: the pole responsible for this instability is not the Maxwellian Landau pole. The analytic value of the Landau pole was determined in a quasi-linear theory. (auth)

10584 HIGHER-ORDER TEMPORAL AND SPATIAL PLASMA-WAVE ECHO CALCULATIONS. Bachmann, P.; Sauer, K.; Wallis, G. (Institut fuer Elektronenphysik, Berlin). Phys. Lett.; 30A: 533-4(29 Dec 1969).

The collisionless Boltzmann equation is solved by an iterative characteristic method to calculate temporal and spatial plasma wave echoes of arbitrary order neglecting self-consistent fields. Using this model the measured spatial echo amplitude dependence from the transmitter separation is explained. (auth)

10585 SELF-EXCITED SUBHARMONIC OSCILLATIONS IN PLASMAS PRODUCED BY LOCAL ELECTRON CYCLOTRON RESONANCE. Abe, H.; Kitagawa, Y.; Tanaka, S. (Kyoto Univ.). Phys. Lett.; 30A: 527-8(29 Dec 1969).

Self-excitation of subharmonics and their higher harmonics of a low-frequency oscillation, which seems to be ascribed to the current-convective instability, is observed. (auth)

10586 INTERACTIONS OF SIMPLE ELECTROMAGNETIC WAVES IN NONLINEAR MEDIA WITH SATURATION. Kolesnikov, P. M. Zh. Tekh. Fiz.; 39: 1742-9(Oct 1969). (In Russian).

An analytical solution is obtained for the problem of finite-amplitude magnetic wave interactions in nonlinear saturated media. A method is suggested for determining the properties of the media according to the wave conditions. A numerical solution is given for the boundary-value problem of electromagnetic wave propagation on a limited section. (tr-auth)

10587 NONLINEAR GENERATION OF PLASMA WAVES BY A CLUSTER OF TRANSVERSE WAVES. IV. Tsylovich, V. N. (Lebedev Inst. of Physics, Moscow). Zh. Tekh. Fiz.; 34: 1756-69(Oct 1969). (In Russian).

Increments of nonlinear generation of low-frequency plasma oscillations with the absence of strong magnetic fields were studied. Attention was given to the effects of plasma heating during excitations of intensively absorbed low-frequency oscillations. A new type of plasma nonlinear dissipative instability in the presence of intense beams of transverse waves was examined, and branches of low-frequency oscillations that represented a weak buildup of second sound were found. (R.V.J.)

10588 WAVE KINETICS IN ANISOTROPIC PLASMA. II. Suramlishvili, G. I. Zh. Tekh. Fiz.; 39: 1774-80(Oct 1969). (In Russian).

Wave kinetic processes in anisotropic plasma were studied, considering ion-acoustic Alfven wave emission and scattering of one helicon by the other. Characteristics of weakly turbulent anisotropic plasma produced by the above processes were determined considering the frequency of ion-acoustic wave collisions with Alfven waves, the rate of energy density increase of ion-acoustic waves produced as a result of Alfven wave breakup, and the frequency of helicon collisions and energy of their interactions. (tr-auth)

10589 INFLUENCE OF ION-ION COLLISIONS ON NONLINEAR INTERACTIONS OF LANGMUIR WAVES IN PLASMA. Makhan'kov, V. G.; Shchinov, B. G. (Joint Inst. for Nuclear Research, Dubna, USSR). Zh. Tekh. Fiz.; 39: 1786-94(Oct 1969). (In Russian).

The influence of ion-ion collisions on the linear interactions of Langmuir waves in a nonisothermal ($T_e > T_i$) completely ionized plasma was studied. It is shown that, at certain plasma parameters, the intermediate pumping related to the ion-ion collisions may change significantly the character of nonlinear spectral transfer of energy, even of not very intense Langmuir oscillations. (tr-auth)

10590 NONLINEAR DISSIPATING INSTABILITY OF MAGNETO-ACOUSTIC WAVES. Oraevskii, V. N.; Pavlenko, V. P. (Kiev Inst. of Physics). Zh. Tekh. Fiz.; 39: 1799-1802(Oct 1969). (In Russian).

Nonlinear conversion of waves for the case of three triple-plasma interactions was studied. It was found that the waves, stable in relation to the breakup in the case of absence of dissipation, are unstable. A case of magneto-acoustic conversion into other types of magnetohydromagnetic waves is examined as an example for illustrating the mentioned instability. (tr-auth)

10591 REFLECTION OF ELECTROMAGNETIC WAVES FROM PLASMA LAYERS. Miroshnichenko, V. I. (Kharkov Inst. of Physics and Tech.). Zh. Tekh. Fiz.; 39: 1954-8(Nov 1969). (In Russian).

The reflection and absorption of s- and p-polarized electromagnetic waves with an oblique incidence to the semi-confined layered plasma medium formed by alternating plane-parallel layers of two types were studied. The plasma boundaries were assumed to be clearly outlined and the electron reflection from these boundaries either mirrored or diffused. An expression was obtained for surface impedance which was investigated for the case of weak spatial dispersion of a medium consisting of thin plasma layers with many structure spacings in the skin-layer stack. (tr-auth)

10592 LOW-FREQUENCY WAVES IN A PLASMA COLUMN AND THEIR EFFECT ON PLASMA RESONANCES. Johnson, Curtis Drew. Riverside, Calif.; Univ. of California (1968). 149p.

Thesis.

Experimental and theoretical studies are presented for the propagation of low-frequency waves in a plasma column and the effect of these waves on plasma resonances. A theory is developed predicting the nature of longitudinal waves in a plasma column where the wave frequency is less than the ion plasma frequency. The theory includes the effects of electron temperature and electron and ion drift velocity along with the specific boundary condition that the radial electron velocity vanish at the column wall. The predicted waves represent an extension of the infinite plasma ion-acoustic wave into a bounded medium. Experimental studies of spontaneous waves in an argon plasma are shown to compare well with theoretical predictions. Collisional and Landau damping effects are discussed. A theory is developed showing how electron density fluctuations, as from propagating waves, can substantially alter the appearance of plasma wave resonances in a plasma column. Excellent agreement is found between the predictions of the theory and observations of plasma resonances in an argon plasma column which contains density fluctuations. (Diss. Abstr.)

10593 DRIFT WAVES IN NONLINEAR REGIME. Hai, Francis. Los Angeles; Univ. of California (1969). 128p.

Thesis.

The nonlinear phenomenon of parametric excitation of stable resonant drift modes through mode-mode coupling is examined in the potassium plasma of a Q device. The scheme investigated extensively is the degenerate case of three-mode parametric coupling in which the stable resonant mode ($m = 1$) at ω_1 is excited by the externally driven pump mode ($m = 2$) at $\omega_0 = 2\omega_1$. The usual frequency and wave number matching conditions are satisfied. The additional, new aspects examined are the enhancement of thermal fluctuations, the threshold for excitation, and the power balance between the coupled modes and the external source. The main results obtained are the measurement of the coupling coefficient and the determination of the functional behavior of the modes. General agreement between the experimental results and theory derived from the expansion of the governing fluid equations to second order is attained. To describe the steady state amplitudes observed experimentally, nonlinear saturation phenomena are included. Nondegenerate and higher order coupling schemes are briefly considered. Parametric coupling as a mechanism limiting the amplitude of an unstable mode and leading to a turbulent plasma is presented and discussed. Nonlinear oscillatory phenomena associated with a single collisional drift mode are investigated in the potassium plasma of a Q device. Examination of the transient and steady state responses of the cylindrical plasma to external excitation of drift waves shows that a simple linear oscillatory analog description is appropriate. Extension to the nonlinear description is achieved by the assumption that nonlinearity stems primarily from the change of the density

gradient occurring with drift wave induced diffusion. This quasi-linear, phenomenological approach results in the familiar analog, the van der Pol oscillator, which describes the following nonlinear variations observed experimentally (1) Temporal damping associated with a stable drift mode increases with wave amplitude; (2) The steady state amplitude of an unstable drift mode follows somewhat the linear growth rate, (3) The bandwidth for synchronization of an unstable mode of small amplitude by an externally driven mode varies directly with the amplitude of the driven mode and inversely with the amplitude of the unstable mode. (Diss. Abstr.)

10594 NONLINEAR PROCESSES OF INFINITE HOMOGENEOUS PLASMAS. Sloan, Millard Lee. Austin, Tex.; Univ. of Texas (1968). 98p.

Thesis.

A theoretical investigation of nonlinear processes in an infinite, homogeneous plasma was undertaken. The mode-coupling equations were put into a convenient form by defining the plasmon number density in a suitable manner — in this form, the conservation laws of wave energy and momentum and the entropy law for three wave interactions were easily derived. A general stability criteria for the nonlinear three-wave interactions was derived and some simple, yet powerful, sufficiency conditions were found and applied to several beam plasma configurations. The effects of nonlinear Landau damping relative to the problem of stability was next investigated. Again, the energy and momentum conservation laws are easily demonstrated, as well as the non-negative character of the diffusion coefficient (evaluated to fourth order in the electric field strength) for resonant particles. For adiabatic electrons it is shown that the ion contribution to the matrix elements governing the nonlinear Landau damping, as well as the three wave terms, is small compared to electron effects; furthermore, the three wave matrix element is negligible compared to four-wave processes, which indicates that nonlinear Landau damping due to the four wave processes is the dominant nonlinear process in a wide variety of cases. The time development of a two-stream ion beam plasma with adiabatic electrons is then discussed; a nonlinear Landau damping instability mechanism was found which allowed the electrons to be heated indefinitely, leading to a linear ion-streaming instability. The effects of finite length and convection of these modes were discussed, and a critical length was derived for the above mentioned configuration. (Diss. Abstr.)

10595 KINETIC THEORY OF PLASMA WAVES IN A MAGNETIC FIELD. Baldwin, David E.; Bernstein, Ira B.; Weenink, M. P. H. (Yale Univ., New Haven). Contract AT(30-1)-3568. Advan. Plasma Phys.; 3: 1-125(1969).

The theory of small-amplitude waves in an infinite homogeneous plasma where an explicit general solution is possible is first discussed. Two problems are dealt with in some detail: (1) resonances in plasma columns, and (2) the geometric optics of a hot magnetoplasma with application to synchrotron radiation loss. (M.O.W.)

Shielding

Refer also to abstracts 9668, 10217, 10650, 10725, 10871, 10872, and 10945.

10596 ANALYTICAL RADIATION SHIELDING CALCULATIONS FOR CONCRETE: FORMULAS AND PARAMETERS. Schmidt, F. A. R. (Oak Ridge National Lab., Tenn.). Nucl. Eng. Design; 10: 308-24(Jul 1969).

Formulas for analytical radiation shielding calculations are discussed in view of their applicability to concrete shielding. Based on neutron removal–diffusion theory and gamma-ray buildup factors, they provide a reasonable tool to compare shielding properties of different concretes. Therefore, parameters for these formulas were calculated from recent cross sections. A sample calculation is given for the concrete tested at the Oak Ridge National Laboratory (USA) Tower Shielding Facility. (auth)

10597 SPATIAL DISTRIBUTION OF EPITHERMAL NEUTRONS IN A TWO-LAYERED MEDIUM WITH CYLINDRICAL BOUNDARY. Rudyk, B. M. Tr., Vses. Nauch.-Issled. Inst. Yadern. Geofiz. Geokhim.; No. 1, 89-106(1968). (In Russian).

An approximate expression is derived for the distribution function of epithermal neutrons in a two-layered medium with cylindrical boundary for the case of a point source of fast neutrons situated on the axis of symmetry in the inner medium. The distribution of neutrons is determined by solving the kinetic equation under several assumptions. (Geophys. Abstr.)

10598 APPLICATIONS OF THE TRANSMISSION MATRIX METHOD TO GAMMA TRANSPORT. Boulette, E. Thomas; Rohach, Alfred F. (Iowa State Univ., Ames). Nucl. Eng. Design; 10: 381-7(Jul 1969).

The applicability of the transmission matrix method to gamma radiation transport is investigated The general idea of this concept is that the transmission and reflection properties of a shield can be described by matrices which give the outgoing angular and energy distribution in terms of incoming distributions. The transmission matrix method is employed to calculate energy buildup factors for homogeneous water, lead, and uranium shields of various thicknesses. In addition, two-layer shields made up of lead and water laminae are investigated and energy buildup factors versus fractional composition are calculated. The transmission of secondary gammas produced by thermal neutron capture is also investigated. The analysis involves the approximation of a secondary gamma distributed source by a finite number of infinite plane gamma sources. The total energy transmitted is calculated and plotted versus the number of plane sources required in the approximation. (auth)

10599 APPROXIMATE TRANSMISSION DOSE BUILDUP FACTOR FOR STRATIFIED SLABS. Harima, Yoshiko; Nishiwaki, Yasushi (Tokyo Inst. of Tech.). J. Nucl. Sci. Technol. (Tokyo); 6: 711-14(Dec 1969).

A new empirical formula is proposed that is physically justifiable and that permits rapid and easy calculation of the transmission dose buildup factors for stratified slabs, composed of any given combination of materials. It is necessary to know only the transmission dose buildup factors for single slabs of the materials constituting the stratified geometry and their attenuation coefficients. Good agreement is obtained with Monte Carlo results. (M.H.R.)

Solid-State Physics

Radiation Effects

Refer also to abstract 9731.

10600 OPTICAL ABSORPTION OF Cl_2^- HOLE-TYPE CENTERS IN IRRADIATED ALKALI HALIDE–ALKALI BORATE GLASSES. Griscom, D. L. (Naval Research Lab., Washington, D. C.). J. Chem. Phys.; 51: 5186-7(1 Dec 1969).

The optical absorption spectrum of 7.5% KCl–22.5% $KO_{\frac{1}{2}}$–70% B_2O_3 glass was measured before and after gamma irradiation. Two radioinduced bands were observed, a strong one at 338 nm and a weaker one at ~700 nm; they correspond well with the $^2\Sigma_\mu^+ \rightarrow {}^2\Sigma_g^+$ and $^2\Sigma_\mu^+ \rightarrow {}^2\Pi_g$ transitions of Cl_2^- in alkali chlorides. The 338-nm band and ESR absorptions correlate well over a wide range of doses. Irradiated potassium borate glasses without chloride did not show any such bands. (D.L.C.)

10601 OSCILLATING STRUCTURE OF THERMAL ANNEALING OF RADIATION DAMAGE REVEALED BY NEUTRON DIFFRACTION. Dimotakis, P. N. (Democritos Nuclear Research Centre, Athens). Nature (London); 224: 1198-9(20 Dec 1969).

In previous radiochemical studies on the fine structure of the isothermal annealing curves of neutron-irradiated solid compounds, an oscillating structure was always found for the isotherms, irrespective of the chemical constitution of the lattice and the nuclear events producing the recoil radionuclides. The phenomenon thus seems to be based on some general property of a radiation-damaged lattice. Similar annealing behavior for radiation damage detected by neutron diffraction is described using single crystals of similar compounds. Tris-ethylenediamine cobalt nitrate and chloride were reactor-irradiated for 1 hr in a position where the thermal and fast neutron fluxes were 4.18×10^{12} and 2.6×10^{11} n/cm^2/sec, respectively, with an absorbed γ dose of about 30 mrad. After irradiation, the crystal was oriented to give an internal-diffracted neutron beam at the MAN neutron spectrometer of the reactor. During isothermal annealing, the sample was heated by infrared lamps. Isothermal annealing at 100°C of a crystal of the nitrate showed an oscillating curve, reproducible for a given crystal, and similar in time period to that obtained in the radiochemical studies. Curves for higher temperatures showed faster oscillations. It is pointed out that whereas the radiochemical measurements record recombination events affecting only a very small number of lattice units, the neutron diffraction data must relate to macroscopic effects in the crystal, and presumably reflect the gradual re-establishment of the regular lattice spacing of the crystal during annealing. (UK)

10602 EFFECT OF NUCLEAR IRRADIATION ON THE PROPERTIES OF ORDERING SOFT MAGNETIC ALLOYS. Artsishevskii, M. A.; Zusman, A. I. (Central Scientific-Research Inst. of Ferrous Metallurgy, Moscow). Ukr. Fiz. Zh.; 14: 1737-40(Oct 1969). (In Russian).

The effects of neutron irradiation on the magnetic properties of ordering soft magnetic alloys were studied up to 10^{17} n/cm² at 100 to 300°C. Development of directed order is the basic reason for the change in the magnetic properties with irradiation at small doses. The influence of the isotropic order on the magnetic properties increases with the dose. (auth)

10603 EPR IDENTIFICATION OF THE STRUCTURE OF THE V_1 COLOR CENTER IN KCl. Patten, F. W.; Keller, F. J. (Naval Research Lab., Washington, D. C.). Phys. Rev.; 187: 1120-7(15 Nov 1969).

EPR spectra have been observed in KCl for a radiation-induced defect center having the same optical and thermal bleaching properties as the center responsible for the V_1 optical-absorption band. The spectra are interpreted as due to an interstitial Cl^0, or an H center, adjacent to a substitutional cation impurity, most likely Na^+. The impurity ion is in the {100} plane containing the H-center bonding axis and is located nearest the midpoint of the H center. The hyperfine principal axes of the two central Cl nuclei, which are coincident with their bonding axes, are inclined 2.8° and 8.8° from a ⟨110⟩ direction toward the impurity ion. An analysis of motional effects on the EPR spectra leads to the following values for the activation energy for reorientation: 0.027 eV for the H centers, 0.035 eV for the V_1 center. (auth)

10604 STUDIES ON NONMETALS DURING IRRADIATION: THE GROWTH AND DECAY OF F CENTERS IN KCl AT 20° C. Levy, P. W.; Mattern, P. L.; Lengweiler, K. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Lett.; 24: 13-16 (5 Jan 1970).

In KCl, the F center-versus-dose curves obtained by making absorption measurements during gamma-ray irradiation differ considerably from those made by irradiating a crystal and then transferring it to a spectrophotometer. When the source is "turned off," the absorption drops abruptly for approximately 30 min and more slowly thereafter. The growth is accurately described by a sum of three saturating exponential terms and one linear term; the decay by the sum of four decreasing exponentials. (auth)

10605 ANALYSIS OF RADIATION-ENHANCED DIFFUSION OF ALUMINUM IN SILICON. Itoh, Tadatsugu; Ohdomari, Iwao (Waseda University, Tokyo). J. Appl. Phys.; 41: 434-6(Jan 1970)

Irradiation of Al-implanted Si results in a step-like diffusion profile. A model is presented in which an order–disorder interface exists between inner host crystal and the surface damage layer which acts as a source of interstitial Si, vacancies, and Al atoms. Calculations are made of the profiles of vacancies and substitutional Al atoms, the results are in good agreement with experiment, with the order–disorder interface at a depth of 500 Å. (D.L.C.)

10606 OPTICAL REFLECTION STUDIES OF DAMAGE IN ION-IMPLANTED SILICON. McGill, T. C.; Kurtin, S. L.; Shifrin, G. A. (Hughes Research Labs., Malibu, Calif.). J. Appl. Phys.; 41: 246-51(Jan 1970).

Optical (3 to 6.5 eV) reflection spectra are presented for crystalline Si implanted at room temperature with 40-keV Sb ions to doses of less than 2×10^{15}/cm². These spectra, and their deviation from the reflection spectrum of crystalline Si, are discussed in terms of a model based on the average dielectric properties of the implanted region. For samples having a high ion dose (>10^{15}/cm²) the observed spectra resemble the spectra of sputtered Si films. Anneal characteristics of the reflection spectra are found to be dose-dependent. These observations are compared to and found to substantiate the results of other experimental techniques for studying lattice damage in Si. (auth)

10607 X-RAY DIFFRACTION FROM NEUTRON-IRRADIATED VITREOUS SILICA. Bale, Harold D.; Shepler, Robert E.; Gibbs, Garry W. (Univ. of North Dakota, Grand Forks). J. Appl. Phys.; 41: 241-6(Jan 1970).

Both large-angle and small-angle diffraction studies were made on pile-irradiated silica glass. The radial distribution curves obtained from the large-angle scattering were in essential agreement with the earlier work of Simon. The small-angle scattering from samples irradiated with a relatively low fast-neutron dose showed a noticeable rise in the scattering at the smallest angles. Two possible causes of this scattering are suggested. In addition, all irradiated samples showed a general increase in the scattering over the entire small-angle region. This scattering which showed little angular dependence was attributed to increased density fluctuations within the sample after irradiation. The irradiation-induced scattering was almost completely removed by annealing the glass at 1300°C. (auth)

Physical Properties

Refer also to abstracts 9723, 10065, 10072, 10166, and 10477.

10608 (CEA-R-3912) STUDY OF THE MAGNETIC SUSCEPTIBILITIES OF SOME PLUTONIUM DERIVATIVES. Raphael, Georges (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Dec 1969. 129p. (In French). Dep. CFSTI (U. S. Sales Only).

Thesis. Submitted to Univ. of Paris, Faculte des Sciences, Orsay, France.

A detailed description is presented of an automatic recording apparatus for magnetic susceptibility measurements on radioactive samples in the temperature range 4 to 1200°K. Measurements were carried out on the following plutonium compounds: PuO_2, Pu_2O_3, PuO_{2-x} PuS, Pu_2S_3, Pu_3S_4, $(U_xPu_{1-x})S$, PuN, PuC_{1-x} (N,O, H,□), Pu_2C_3, $(U_{0.85}Pu_{0.15})$ C. The curves of susceptibilities vs. temperature show many magnetic transitions. Interpretation of these results shows the existence of magnetic moments carried by the 5f electrons and localized on the metallic sites, as well as the great influence of the "crystal field" in all these compounds. (auth)

10609 (STI/PUB-187(Vol.1)) NEUTRON INELASTIC SCATTERING. VOLUME I. Proceedings Series. Proceedings of a Symposium Held in Copenhagen, 20–25 May 1968. (International Atomic Energy Agency, Vienna (Austria)). Sep 1968. 652p. (In several languages). (CONF-680501-(Vol.1)). IAEA $15.00.

This volume contains 82 papers, reviews, and discussions under the following headings: Dynamics of Solids (lattice vibrations and local modes, metals, alloys, and nonmetals), and Dynamics by Liquids (coherent neutron scattering and neutron scattering on hydrogenous liquids). Separate abstracts were prepared for 9 of the papers. (D.L.C.)

For abstracts of individual papers see: 10478, 10616–10622, and 10901.

10610 (STI/PUB-187(Vol.2)) NEUTRON INELASTIC SCATTERING. VOLUME II. Proceedings Series. Proceedings of a Symposium Held in Copenhagen, 20–25 May 1968. (International Atomic Energy Agency, Vienna (Austria)). Sep 1968. 465p. (In French and English). (CONF-680501-(Vol.2)). IAEA $11.00.

This volume contains 62 papers, reviews, and discussions under the following headings: Magnetic Systems, Molecular Dynamics, and Experimental Methods (neutron spectrometers). Separate abstracts were prepared for 18 of these papers. One of the remaining papers was previously abstracted (see NSA 22: 19133). (D.L.C.)

For abstracts of individual papers see: 9679–9689, 10376, 10628–10630, and 11280–11282.

10611 THEORY FOR THE GIANT SUSCEPTIBILITIES OF DILUTE MAGNETIC ALLOYS. Bennemann, K. H. (Univ. of Rochester, N. Y.); Garland, J. W.; Mueller, F. M. Phys. Rev. Lett.; 23: 1503-7(29 Dec 1969).

The giant susceptibilities and their suppression by small magnetic fields observed for dilute La–rare-earth alloys are explained quantitatively by assuming clustering of localized spins. (auth)

10612 THE STRUCTURE AND CHEMISTRY OF SOLID SURFACES. Proceedings of the Fourth International Materials Symposium Held at Berkeley, California, June 17–21, 1968. Somorjai, Gabor A. (ed.). Inorganic Materials Research Division Series. New York; John Wiley and Sons, Inc. (1969). 1498p. (CONF-680611).

The papers concentrate on both theoretical and experimental studies of well-defined or single-crystal surfaces in a controlled ambient (ultrahigh vacuum or in the presence of pure gases), emphasizing the correlation between atomic and electronic structure and transport properties of clean solid surfaces, and the chemistry of surface reactions. The first part of the book treats properties of clean surfaces; the second part deals with gas covered surfaces and chemical surface reactions. (W.D.M.)

10613 FIZYKOCHEMIA CIALA STALEGO. WYBRANE ZAGADNIENIA. (Physical Chemistry of the Solid State. Selected Problems). Stalinskiego, Bohdana. Warszawa; Panstwowe Wydawnictwo Naukowe (1967). 308p.

This book contains nine chapters dealing with selected problems of solid-state chemistry. Although each chapter presents the subject in a closed way, there are common features which join all the chapters together. These are the problems of crystal structure and phase equilibria, as well as the correlations between the various physical properties of selected groups of compounds and their crystal structures. (W.D.M.)

10614 THERMAL CONDUCTIVITY OF POLYCRYSTAL INDIUM BELOW 1°K. Leyarovski, Evgenii; Zakharieva, Magdalina. Izv. Fiz. Inst. Aneb, Bulg. Akad. Nauk.; 19: 73-83(1969). (In Bulgarian).

The thermal conductivity of an indium foil (99.992%) is measured in the temperature range 0.27 – 2°K in a superconductive as well

as in a normal state. A transition towards a pure phonon conductivity ($\lambda \sim T^3$) was observed in the superconductive state at T = 0.6°K. The electron thermal conductivity of indium in the superconductive state follows an exponential dependence of T in accordance with the existing microscopic theories of transport phenomena in superconductors. In the normal state in the whole investigated temperature range, the thermal conductivity of indium is in satisfactory accordance with the Wiedemann–Franz law. (auth)

10615 INFLUENCE OF THE MAGNETIC FIELD ON THE THERMAL CONDUCTIVITY OF INDIUM AT TEMPERATURES BELOW 1°K. Leyarovski, Evgenii; Zakharieva, Magdalina. Izv. Fiz. Inst. Aneb, Bulg. Akad. Nauk.; 19: 85-93(1969). (In Bulgarian).

The dependence of the thermal conductivity on the cross-sectional (up to 10^6 A/m) and longitudinal (up to 8×10^4 A/m) magnetic field for a thin indium foil cylinder of high purity is studied in the 0.35 – 1.1°K temperature interval. The effect of "freezing" of "normal" regions from 4.2 to 0.43°K is observed in a cross-sectional field expressed in a considerable hysteresis of the thermal resistance for a field strength decrease. A clearly expressed minimum of the curve $\lambda = f(H)$ is observed in a longitudinal field for field strength increase just before the transition to a normal state in the phonon (0.35°K) as well as in the electron (0.84°K) conductivity. The results are interpreted from the point of view of a unique "intermediate" state. (auth)

10616 LOCALIZED AND BAND PHONONS IN Ta_{88}–Nb_{12} STUDIED BY COHERENT INELASTIC NEUTRON SCATTERING. Als-Nielsen, J. (Risoe Research Establishment, Roskilde, Denmark). pp 35-42 of Neutron Inelastic Scattering. Vol. I. Vienna; International Atomic Energy Agency (1968).

From Symposium on Inelastic Neutron Scattering, Copenhagen, Denmark. See STI/PUB-187(Vol.1); CONF-680501-(Vol.1).

It is probable that substitution of Nb atoms in a Ta crystal does not alter the force constants significantly, so in a Ta–Nb alloy the Nb atoms can be regarded as nearly pure light-mass defects. These give rise to a localized mode of vibration with a frequency above the frequency band for pure Ta lattice vibrations. The lattice vibrations of an 88 at.% Ta–12 at.% Nb alloy were studied by inelastic neutron scattering, using a triple-axis spectrometer in its constant-q mode of operation. In particular, the scattered intensity was measured as a function of energy transfer, with q fixed along the (1,0,0) direction and perpendicular to the scattering vector. It was not possible to resolve the band phonons from the localized phonon into two separate neutron energy groups. However, a tail at the high-energy side of the band phonon peak at $q = 1.5$ Å^{-1}, as well as an anomalous broadening of the peaks at $q = 1.7$ Å^{-1} and $q = 1.9$ Å^{-1}, are interpreted as deriving from a localized mode of vibration. Its energy is 23.2 ± 0.2 meV, not far from the value of 22.55 meV calculated from the mass-defect theory using the frequency spectrum for Ta determined by Woods. The band phonons are shifted upwards in energy, although the dispersion curve becomes very flat or even decreases for $q > 1.5$ Å^{-1}. (auth)

10617 LOCALIZED MODES, RESONANT MODES, AND IMPURITY VIBRATIONAL BANDS IN VANADIUM ALLOYS. Mozer, B. (National Bureau of Standards, Washington, D. C.). pp 55-63 of Neutron Inelastic Scattering. Vol. I. Vienna; International Atomic Energy Agency (1968).

From Symposium on Inelastic Neutron Scattering, Copenhagen, Denmark. See STI/PUB-187(Vol.1); CONF-680501-(Vol.1).

Inelastic neutron scattering data have been obtained on several vanadium alloys using time-of-flight techniques. Localized impurity modes of vibration and a split impurity band have been observed in Be_xV_{1-x} alloys for $0.75 < x < 3.3$ at.%. The frequency of the localized mode observed in the lower concentration alloys occurs at about 0.047 eV, in agreement with the frequency predicted for a single isotopic impurity of the same mass ratio of beryllium to vanadium and using the experimental vanadium frequency distribution cut-off at 0.031 eV. As the concentration of beryllium is increased, the localized mode peak broadens and finally splits into two peaks at 3.3 at. % concentration of beryllium. Several theories of vibrational spectra of disordered alloys indicate structure in the impurity band; the theory favored for the explanation of the experiments is one that includes correlation of pairs of impurities. Assuming the observed splitting is caused by the proximity of another impurity, one finds the decay constant of the localized mode to be $2.5\ a_0^{-1}$. Heavy mass atoms have been alloyed with vanadium to observe resonant modes of vibration and changes in the over-all frequency distribution. Inelastic neutron data were obtained on Ta_xV_{1-x}, W_xV_{1-x} and $Pt_{0.05}V_{0.95}$ alloys. None of the data for these alloys show peaks at the resonant mode frequencies expected for a single impurity or for resonant mode structure for a measurable concentration of impurities. Estimates of the effect expected for heavy solute atoms based on a single impurity calculation or an approximate theory of many impurities indicate resonant mode structure 20 to 50% above background for the alloys used when instrumental resolution is included. Such a large effect is easily observable within the accuracy of our experiments, yet no peaks were observed and even very little structure was observed in the ratio of the alloy data to pure vanadium data. An absence of resonant mode structure in our experiments and the small effects observed in experiments of other researchers indicate a more sophisticated theory is required which includes pair correlation of impurities and perhaps anharmonic effects. Experiments have been initiated on alloys when the solute atoms have very different charge configurations than vanadium. Measurements of Cr, $Cr_{0.25}V_{0.75}$, and $Ni_{0.05}V_{0.95}$ have been made and frequency distributions estimated. Comparison of the high-frequency part of the spectrum for the pure metals and the $Ni_{0.05}$–$V_{0.95}$ alloy with $Cr_{0.25}V_{0.75}$ spectrum indicates that Ni atoms contribute 10 electrons to the electron bands. The additional Coulomb attraction of the +10 nickel ion is not strong enough to form bound states for the extra electrons and is indirect proof that localized electron states do not exist in this alloy. (auth)

10618 INVESTIGATION OF ADMIXED STATES IN VANADIUM ALLOYS. Zemlyanov, M. G.; Mironov, S. P.; Syrykh, F. G. (Inst. of Atomic Energy, Moscow). pp 79-85 of Neutron Inelastic Scattering. Vol. I. Vienna; International Atomic Energy Agency (1968). (In Russian).

From Symposium on Inelastic Neutron Scattering, Copenhagen, Denmark. See STI/PUB-187(Vol.1); CONF-680501-(Vol.1).

Results are given of research into quasi-local states caused by the introduction of different substitutional atoms of impurities into a vanadium metal crystal lattice. The results are compared with theoretical calculations carried out using different model assumptions, and with other experimental work. The inelastic scattering of cold neutrons was carried out on an assembly at the IRT-M reactor at the Kurchatov Institute of Atomic Energy. The spectral line of incident neutrons is established using a beryllium filter cooled by liquid nitrogen and a mechanical chopper. The energies of neutrons scattered at an angle of 90° are analyzed at a distance of 4.5 m by the time-of-flight method. The excitation spectra are established with allowance for all necessary instrument corrections. (auth)

10619 THEORY OF VIBRATIONAL SPECTRUM IN HEXAGONAL METALS. Brovman, E. G.; Kagan, Yu.; Holas, A. (Inst. of Atomic Energy, Moscow). pp 165-79 of Neutron Inelastic Scattering. Vol. I. Vienna; International Atomic Energy Agency (1968). (In Russian).

From Symposium on Inelastic Neutron Scattering, Copenhagen, Denmark. See STI/PUB-187(Vol.1); CONF-680501-(Vol.1).

The previously developed general theory of vibrational spectrum in metals, based on separation of the long and short-range interionic interactions in the electron–ion system, is applied to the analysis of the phonon spectrum in the hexagonal metals Be, Mg, and Zn. The long-range interaction is demonstrated with help of the concrete form of the pseudo-potentials in these metals, while the parameters of the short-range interactions are determined from some experimental quantities. The essential role of the short-range interaction is demonstrated. A detailed comparison of theory with experiment is given. (auth)

10620 DYNAMICS OF HYDROGEN IMPURITIES IN NIOBIUM AND VANADIUM. Verdan, G.; Rubin, R.; Kley, W. (EURATOM–CCR, Ispra, Italy). pp 223-31 of Neutron Inelastic Scattering. Vol. I. Vienna; International Atomic Energy Agency (1968).

From Symposium on Inelastic Neutron Scattering, Copenhagen, Denmark. See STI/PUB-187(Vol.1); CONF-680501-(Vol.1).

The inelastic scattering of cold neutrons in single crystals of vanadium hydride and niobium hydride revealed local modes at $E_1^V = 167 \pm 6$ MeV, $E_2^V = 123 \pm 6$ MeV and $E_1^{Nb} = 177 \pm 6$ MeV, $E_2^{Nb} = 114 \pm 6$ MeV. From a measurement of the width function of hydrogen in polycrystalline niobium, the diffusion constant $D(200°C) = 2 \times 10^{-15}$ cm^2/sec and the time between diffusive jumps $\tau = 1.3 \times 10^{-12}$ sec could be determined. (auth)

10621 PHONON DISPERSION RELATION OF BERYLLIUM OXIDE. Ostheller, G. L.; Schmunk, R. E.; Brugger, R. M.; Kearney, R. J. (Idaho Nuclear Corp., Idaho Falls). pp 315-24 of Neutron Inelastic Scattering. Vol. I. Vienna; International Atomic Energy Agency (1968).

From Symposium on Inelastic Neutron Scattering, Copenhagen, Denmark. See STI/PUB-187(Vol.1); CONF-680501-(Vol.1).

The phonon dispersion relation measurements for BeO have been extended by neutron inelastic scattering, using the MTR triple-axis spectrometer. New data include a transverse acoustic branch and an optical branch with wave propagation in the [01$\bar{1}$0] direction

and in addition the transverse acoustic, longitudinal acoustic, and a transverse optic branch, all with wave propagation in the [0001] direction. The two optical branches observed are degenerate at the center of the Brillouin zone with a frequency $\omega = 6.21 \pm 0.11 \times 10^{13}$ rad/sec. This frequency is in fair agreement with the optical data of Loh which gives $\omega = 6.41 \times 10^{13}$ rad/sec for the same mode. From the neutron scattering data of this experiment and the optical data of Loh, it appears that the low-lying optical branches reported previously by Brugger et al. are not single-phonon data but are the result of multiphonon processes. Comparison is made between the measured branches of the dispersion relation and the results of preliminary lattice dynamics model calculations by Young and by Solbrig. (auth)

10622 THE PHONON DISTRIBUTION OF GRAPHITE AT HIGH TEMPERATURES. Page, D. I. (Atomic Energy Research Establishment, Harwell, Eng.). pp 325-34 of Neutron Inelastic Scattering. Vol. I. Vienna; International Atomic Energy Agency (1968).

From Symposium on Inelastic Neutron Scattering, Copenhagen, Denmark. See STI/PUB-187(Vol.1); CONF-680501-(Vol.1).

The phonon spectrum of graphite is notable for the high energy of some of its modes; the cutoff in the frequency distribution is about 0.22 eV (2500°K), and it is difficult to measure accurately the whole of the distribution by neutron-scattering experiments on samples at room temperature. Raising the temperature of the sample, however, increases the probability of high-energy gains by the neutron. Therefore, the inelastic scattering of slow neutrons by graphite at 1800°K was measured using a phased-rotor spectrometer. Energy transfers covering the whole range of the frequency distribution are observed with clearly defined peaks. The results are compared with theoretical predictions and show good agreement. The incoherent approximation is shown to be reasonably valid at this high temperature and a smoothed frequency distribution is given which allows the calculation of scattering cross sections in agreement with data measured at other temperatures. (auth)

10623 ABSORPTION SPECTRUM OF NpO_2^{2+} IN $CsUO_2(NO_3)_3$. Leung, A. F.; Wong, Eugene Y. (Univ. of California, Los Angeles). Phys. Rev.; 187: 504-11(10 Nov 1969).

The absorption spectrum of NpO_2^{2+} doped in $CsUO_2(NO_3)_3$ was studied from 5000 to 22,000 cm^{-1}. Nine electronic levels were identified through their vibronic patterns and magnetic properties. Four of these levels, at 6458, 9420, 17,841, and 20,815 cm^{-1}, are identified as pure electronic excitations within the $5f^1$ configuration. The other five electronic levels at 13,914, 16,071, 16,093, 17,698, and 21,021 cm^{-1} arise from the excited configuration consisting of two 5f electrons and a hole in the bonding electrons. The observed Zeeman effect of the absorption lines at 6458, 9420, 17,841, and 20,815 cm^{-1} agrees roughly with the calculation reported by Eisenstein and Pryce on the spectrum of NpO_2^{2+} doped in $RbUO_2(NO_3)_3$, whose crystal structure is isomorphous to that of $CsUO_2(NO_3)_3$. (auth)

10624 SPECIFIC HEAT OF RARE EARTH NITRIDES. Stutius, W. (Eidgenoessische Technische Hochschule, Zurich). Phys. Kondens. Mater.; 10: 152-85(28 Nov 1969). (In German).

The specific heat of rare earth (RE) nitrides was measured at temperatures between 1.7 and 270°K by means of an adiabatic calorimeter. The various terms contributing to the total specific heat have been separated. The total splitting of the ground-state multiplet of the trivalent RE ions in the octahedral crystal field has been determined. The experimental values agree reasonably well with those calculated with the point charge model. The spontaneous magnetization and the magnetic specific heat below the ordering temperature are calculated with the molecular field theory by taking into account all the 2J + 1 energy levels of the ground-state multiplet and including exchange interaction and crystal-field splitting. Comparison is made with the experimental results, and the values obtained for the exchange energies are listed. (auth)

10625 DENSITY OF STATES IN THE CONDUCTION BAND OF SOME RARE EARTH OXIDES. Bergwall, Staffan; Nigavekar, Arun S. (Uppsala Univ.). Phys. Kondens. Mater.; 10: 107-15 (28 Nov 1969).

The results of a systematic investigation of the intensity distribution near the short-wavelength limit of the continuous x-ray spectrum for the most common rare earth oxides are reported. Anomalies in the band structure of some oxides were observed and are discussed in terms of localized energy levels in the forbidden band due to the existence of color centers. This implies that the physical properties of pure compounds strongly depend on the precise experimental conditions of preparation. (auth)

10626 ELECTRON-SPIN-RESONANCE SPECTRUM OF DIVALENT EUROPIUM IN THORIUM DIOXIDE. Abraham, M. M.; Finch, C. B.; Reynolds, R. W.; Zeldes, H. (Oak Ridge National Lab., Tenn.). Phys. Rev.; 187: 451-5(10 Nov 1969).

Either 2-MeV electron or ^{60}Co γ irradiation was employed to reduce trivalent Eu in ThO_2 to the divalent state. The ESR spectrum of the Eu^{2+} ions could only be observed at temperatures below 77°K and possessed trigonal symmetry about the four ⟨111⟩ axes. The axial crystal field was so strong that only the $|M_J = \frac{1}{2}\rangle$ to $|M_J = -\frac{1}{2}\rangle$ transition was observed with a highly anisotropic g value ($g_{||} = 1.9678 \pm 0.0005$ and $g_{\perp} = 7.867 \pm 0.002$). Hyperfine structure was resolved but the angular variation was complex because of a nuclear quadrupole interaction that was of the same order of magnitude as the hyperfine interaction. Spin-Hamiltonian constants which describe the ESR spectrum were determined with the use of a computer. Electron irradiation at 77°K was not successful in producing Eu^{3+} in isomorphous CeO_2. In addition, crystals of ThO_2 and CeO_2 doped with trivalent thulium were also electron-irradiated at 77°K, but no change in the Tm valence was detected. (auth)

10627 FINE STRUCTURE OBSERVED IN MODIFIED X-RAY SCATTERING BY BORON. Alexandropoulos, N. G.; Cohen, G. G. (Polytechnic Inst. of Brooklyn). Phys. Rev.; 187: 455-9(10 Nov 1969).

Using a double-crystal spectrometer, two portions of the spectrum of Cu $K\alpha_1$, $K\alpha_2$ radiation scattered by boron were recorded. One portion is near the Rayleigh peaks; the other portion is at a distance of about 180 eV from the Rayleigh peaks. Several discontinuities have been noted in the first region. A definite double line was observed in the second region at a distance from the Rayleigh lines which corresponds closely to the energy required for a 1s–2p electron transition. The widths of the observed lines are in agreement with the K boron emission lines. No conclusive results have yet been obtained with regard to the selection rules. It is not clear that the process under investigation is a three-level transition process. (auth)

10628 NEUTRON SPIN SCATTERING BY SPIN WAVES IN METALS. Moeller, H. Bjerrum (Risoe Research Establishment, Roskilde, Denmark). pp 3-27 of Neutron Inelastic Scattering. Vol. II. Vienna; International Atomic Energy Agency (1968).

From Symposium on Inelastic Neutron Scattering, Copenhagen, Denmark. See STI/PUB-187(Vol.2); CONF-680501-(Vol.2).

A review is presented of neutron scattering studies of spin waves in magnetic metals. In the rare-earth metals, such studies have given rather detailed information on the indirect exchange interaction and its relation to the electronic structure. Measurements on the iron-group metals have so far given much less information and no effects which show unambiguously the itinerant character of the magnetic electrons have been observed, probably because spin-wave studies in iron-group metals have only been possible for rather low wavevectors of the spin waves. (auth)

10629 MAGNON ENERGIES AND EXCHANGE INTERACTIONS IN TERBIUM. Houmann, J. C. Gylden (Risoe Research Establishment, Roskilde, Denmark). pp 29-35 of Neutron Inelastic Scattering. Vol. II. Vienna; International Atomic Energy Agency (1968).

From Symposium on Inelastic Neutron Scattering, Copenhagen, Denmark. See STI/PUB-187(Vol.2); CONF-680501-(Vol.2).

The magnon density of states, and hence the magnetic contribution to the specific heat, together with the exchange interaction between ions in the same sublattice were calculated for Tb at 90°K, using experimental results obtained by inelastic neutron scattering. (auth)

10630 INELASTIC CRITICAL NEUTRON SCATTERING IN TERBIUM. Dietrich, O. W.; Als-Nielsen, J. (Risoe Research Establishment, Roskilde, Denmark). pp 63-74 of Neutron Inelastic Scattering. Vol. II. Vienna; International Atomic Energy Agency (1968).

From Symposium on Inelastic Neutron Scattering, Copenhagen, Denmark. See STI/PUB-187(Vol.2); CONF-680501-(Vol.2).

The critical neutron scattering above the Néel temperature T_N in Tb was measured, using both double-axis and triple-axis spectrometry. The parameters of the magnetic susceptibility and the spin relaxation function were deduced in the temperature range $0.005 \lesssim (T - T_N)/T_N \lesssim 0.06$. Both the inverse correlation range κ_1, and the long wavelength susceptibility $\chi(\vec{Q})$ obey temperature power laws, with the exponents $\mu = 0.66 \pm 0.02$ and $\gamma = 1.33 \pm 0.02$, respectively. The results for the relaxation function show that thermodynamic slowing down of the spin fluctuations does occur in Tb when the temperature approaches the critical temperature. (auth)

10631 DIELECTRIC CONSTANT OF UO_2 AT 9.4 GHz. Gesi, Kazuo; Tateno, Jun (Japan Atomic Energy Research Inst., Ibaraki). Jap. J. Appl. Phys.; 8: 1358-9(Nov 1969).

The complex dielectric constant of UO_2 needles was measured

at 9.4 GHz by a perturbation method using a rectangular cavity. The real part ϵ^1 is 21.0 ± 1 at room temperature and is independent of temperature from −130 to +100°C. The imaginary part ϵ^{11} is $\sim 10^{-2}$ and increases slightly with temperature above 50°C. The results are in good agreement with low-frequency measurements. (D.L.C.)

10632 ELECTRIC AND THERMAL PROPERTIES OF SOLID SOLUTIONS OF THE Zr–Ta–C SYSTEM. Golikova, O. A.; Dzhafarov, E. O. Izv. Akad. Nauk Azerb. SSR, Ser. Fiz.-Tekh. Mat. Nauk: No. 2, 79-82(1969). (In Russian).

The ternary systems of Zr–Ta–C [with the sections of ZrC–TaC, $Zr_{0.5}Ta_{0.5}Cz(Z < 1)$] were studied. Results of measurements of the system's electrical conductivity, thermal emf, Hall coefficient, and thermal conductivity at room temperature are presented. (R.V.J.)

10633 MAGNETIC BREAKDOWN OF OPEN ORBITS IN CADMIUM. Datars, W. R.; Cook, J. R. (McMaster Univ., Hamilton, Ont.). Phys. Rev.; 187: 769-77(15 Nov 1969).

Open orbits in cadmium were investigated in magnetic fields up to 30.5 kOe by an induced-torque method. An analysis of the method is presented. Torque produced by a magnetic field rotating at constant speed is caused by induced, open-orbit current when the magnetic field is perpendicular to the open orbit. The amplitude of the induced torque is related to the open-orbit conductivity. The field dependence of the induced-torque amplitude of the open orbit in cadmium was examined for field directions in the (0001) plane. The torque amplitude tends to saturate at high fields for all directions of observation. This is attributed to magnetic breakdown between the first and second bands through the spin-orbit-induced energy gap at the AHL plane of the Brillouin zone. The magnetic breakdown occurs at low fields and reduces the open-orbit conductivity to a negligible amount at 30 kOe. The analysis is carried out using a linear-chain model to represent the first- and second-band hole surfaces and the theoretical results of Falicov and Sievert. For the [10$\bar{1}$0] field direction, two breakdown probabilities are indicated, corresponding to breakdown through the energy gaps along HL and HA of the Brillouin zone, with an upper breakdown field of approximately 10 kOe. For all field directions in the (0001) plane, the breakdown occurs over a similar range of magnetic field. (auth)

10634 ANTISHIELDING EFFECT OF THE CONDUCTION ELECTRONS ON THE CRYSTALLINE ELECTRIC FIELD IN RARE EARTH METALS. Das, K. C.; Ray, D. K. (Faculte des Sciences, Grenoble, France). Phys. Rev.; 187: 777-80(15 Nov 1969).

The lattice contributions to the crystalline electric field (CEF) parameters for the rare-earth metals have been calculated, taking into account both the point charges and the induced quadrupole moments at the ionic sites. The induced quadrupolar contributions are found to be negligibly small compared with the point-charge contributions. The antishielding factors δ_l due to the conduction electrons are evaluated by comparing the calculated CEF with the experimental results for thulium, cerium, and terbium metals, giving $\delta_2 = 0.44$, $\delta_4 = 1.6$, and $\delta_6 = 0.77$, respectively. These values of δ_l explain fairly well the available information about the CEF parameters of praseodymium, terbium, and dysprosium. The possibility of getting antishielding effects from the direct contributions of the conduction electrons in the neighboring Wigner–Seitz cells is also indicated. (auth)

10635 TEMPERATURE-DEPENDENT OPTICAL PROPERTIES OF Zn AND Cd: A THEORETICAL STUDY. Kasowski, R. V. (Univ. of Chicago). Phys. Rev.; 187: 885-91(15 Nov 1969).

The optical properties of Zn and Cd are investigated theoretically at T = 0°K; a nonlocal empirical pseudopotential determined from Fermi-surface measurements is used to calculate the optical spectra at T = 0°K. To study the temperature dependence of the spectra, the T = 0°K psuedopotential was modified to include lattice vibrations and thermal expansion, and the optical spectra of Cd at T = 462°K then calculated. Fairly good agreement with experiment in regard to line shape is found if these temperature effects are properly taken into account; however, the absolute magnitudes of the calculated optical spectra exceed the experimental values by about a factor of 2. (auth)

10636 INTERACTIONS OF NEUTRONS WITH SOLIDS. Marshall, W.; Lovesey, S. W. (Atomic Energy Research Establishment, Harwell, Eng.). Comments Solid State Phys.; 2: 88-92 (Aug-Sep 1969).

Besides the nuclear and magnetic interactions of neutrons in crystals, two other possible interactions are those with the magnetic field created by nuclear magnetic moments and the electrostatic interaction with the Coulomb field of the nuclei and electrons. Equations are derived for the cross sections and amplitudes of the magnetic and electrostatic interactions, and polarization effects are discussed. (D.L.C.)

10637 POSITRON ANNIHILATION IN COPPER ALLOYS. Murray, Brian W.; McGervey, John D. (Case Western Reserve Univ., Cleveland). Phys. Rev. Lett.; 24: 9-13(5 Jan 1970).

The long-slit geometry has been used to measure the angular correlation of annihilation radiation from copper alloys. The alloys 0.975 Cu−0.025 Al, 0.95 Cu−0.05 Al, and 0.77 Cu−0.23 Ni display "necks" in momentum space. In units of the copper Fermi-surface neck, the measured neck radii of 1.3, 1.5, and 0.8, respectively, are consistent with the assumption that the energy-momentum relation is unchanged upon alloying. (auth)

10638 HYPERFINE FIELD ON IMPURITIES IN GADOLINIUM. Campbell, I. A. (Faculte des Sciences, Orsay, France). Phys. Lett.; 30A: 517-8(29 Dec 1969).

The Daniel–Friedel conduction electron polarization model is used to calculate the polarization at an s–p impurity site in a ferromagnetic Gd host as a function of the number Z of s–p electrons on the impurity. From the results, it is predicted that hyperfine fields for noble-metal impurities in Gd would be small and positive, those for impurities in the middle of the s–p series large and negative, with smaller fields towards the end of the series. The predictions are in general agreement with observations. (D.L.C.)

10639 ELECTRICAL PROPERTIES OF THORIUM CARBONITRIDES. Auskern, A. B.; Aronson, S. (Brookhaven National Lab., Upton, N. Y.). J. Appl. Phys.; 41: 227-32(Jan 1970).

The electrical resistivity, Hall coefficient, and thermoelectric power of thorium carbonitride solid solutions ranging in composition from $ThC_{0.778}N_{0.108}$ to $ThC_{0.629}N_{0.937}$ were measured from 4.2°K to about 400°K. A maximum was observed in each property as nitrogen was substituted for carbon. The results were compared with results on nonstoichiometric thorium monocarbide and thorium mononitride. (auth)

Moessbauer Effects and NMR

Refer also to abstracts 9666, 9718, and 10064.

10640 MOESSBAUER-EFFECT STUDIES IN HAFNIUM-METAL SINGLE CRYSTALS. Boolchand, P.; Robinson, B. L.; Jha, S. (Case Western Reserve Univ., Cleveland). Phys. Rev.; 187: 475-8(10 Nov 1969).

The Moessbauer effect in ^{178}Hf was studied with oriented single-crystal absorbers of hafnium metal at the temperature of liquid helium. Along the [0001] axis, only the $|\Delta m| = 1$ component of the quadrupole spectrum is observed, and along the [10$\bar{1}$0] axis only the $|\Delta m| = 1$ and $|\Delta m| = 2$ components are observed. Combining these observations with those made using a polycrystalline hafnium-metal absorber, the magnitude of the electric field gradient was found to be $V_{zz} = (0.95 \pm 0.04) \times 10^{18}$ V/cm^2, and the asymmetry parameter $\eta < 0.1$. The Debye temperature of hafnium carbide has been estimated to be (350 ± 10)°K, and the Debye temperature of hafnium metal has been found to be (227 ± 10) and (192 ± 13)°K, for γ rays propagating parallel and perpendicular to the c axis, respectively. (auth)

10641 MAGNETIC PROPERTIES OF PLUTONIUM MONOPHOSPHIDE. Lam, D. J.; Fradin, F. Y.; Kruger, O. L. (Argonne National Lab., Ill.). Phys. Rev.; 187: 606-10(10 Nov 1969).

The results of magnetization and NMR measurements of plutonium monophosphide are reported. A paramagnetic moment of 1.06 μ_B was obtained from the χ^{-1}-versus-T plot, above the Curie temperature of 126°K, after subtracting a value of 190×10^{-6} emu/mole for the temperature-independent orbital paramagnetism. A ferromagnetic moment of 0.42 μ_B per formula unit was obtained for PuP. The Knight shift of ^{31}P in PuP is linearly dependent on the magnetic susceptibility above the Curie temperature. An effective hyperfine field of −51 kG was determined from the slope of the K-versus-χ curve. The relaxation rate can be described in terms of the Knight shift $K \equiv K_{PuP} - K_{ThP}$ by $(T_1T)^{-1} = (23.5 \pm 1.7) \times 10^3$K (sec °K)$^{-1}$. The saturation moment is discussed in terms of the localized-5f-electron model, and the NMR results are discussed in terms of the coupling of the conduction electrons and the localized 5f electrons. (auth)

10642 MOESSBAUER EFFECT OF ^{57}Fe IMPURITIES BOUND IN VANADIUM AND VANADIUM HYDRIDES. Simopoulos, A.; Pelah, I. (Soreq Nuclear Research Center, Yavne, Israel). J. Chem. Phys.; 51: 5691-5(15 Dec 1969).

An experimental study is made of the Moessbauer effect of

^{57}Fe in vanadium and vanadium hydride matrices. The recoil-free fraction and second-order Doppler shift were measured over the temperature range 100 to 700°K. The vanadium results are fitted with simple expressions for the mean-square displacement and velocity of the defect at the high-temperature range. Both quantities suggest an increase in force constants in the vicinity of the iron defect. The vanadium hydride samples display a higher recoil-free fraction than the vanadium samples. This is attributed to hydrogen nucleation around the iron defect. (auth)

10643 TEMPERATURE-DEPENDENT KNIGHT SHIFT IN CADMIUM: A THEORETICAL STUDY. Kasowski, R. V. (Univ. of Chicago). Phys. Rev.; 187: 891-901(15 Nov 1969).

Experimentally the Knight shift in Cd is characterized by (1) an increase in the nuclear resonance frequency of more than 70% in the temperature range from 0 to 594°K (melting point), (2) an increase of 33% in the isotropic Knight shift at the melting point, and (3) an increase in the anisotropic Knight shift from a small negative value at T = 0°K to a fairly large positive value at high temperatures. It is found that this temperature dependence is theoretically accounted for by including the effects of lattice vibrations into the electronic structure which was investigated by means of an empirical pseudopotential. The effect of the lattice vibrations is to decrease the strength of the pseudopotential. This makes the energy bands more free-electron-like, and the s character of the wave functions of the Fermi surface increases. It also destroys the cancellation of the contribution of the various p parts of the wave function to the anisotropic Knight shift, thus increasing the anisotropy as well. Many-body corrections were included by means of a temperature-independent enhancement factor and were determined empirically for T = 0°K. The trend of the variation of the Knight shift with temperature, both isotropic and anisotropic, is explained. (auth)

10644 DETERMINATION OF THE THERMAL DIFFUSE SCATTERING IN A SILICON CRYSTAL BY MEANS OF THE MOESSBAUER EFFECT. Ghezzi, C. (Univ., Parma, Italy); Merlini, A.; Pace, S. Nuovo Cim., 64B: 103-16(Nov. 11, 1969).

The 14.4-keV (λ = 0.8602 Å) γ rays from a ^{57}Co source were scattered by the (444) and (555) planes of a perfect silicon crystal and the inelastic contribution to the total scattering was determined by means of the Moessbauer effect. It was found that the thermal diffuse scattering has intensity maxima under the Bragg peak, as expected on the basis of the lattice wave theory of the x-ray diffuse scattering. The ratio between the integrated intensities of the thermal diffuse and the total scatterings was equal to 0.47 and 0.55 for the (444) and (555) reflections respectively, the geometry of the experiment being similar to those commonly used for studies of diffuse scattering. The integrated Bragg intensities of the above reflections were compared with those calculated by using the formulas of the dynamical theory of diffraction. A comparison was also made between the intensities of the thermal scattering at the Bragg angle and those calculated by using some simplifying assumptions for the numerical evaluation of the formulas of the theory. A satisfactory agreement between experimental and calculated values was found for both the Bragg and the thermal diffuse scatterings. (auth)

10645 NUCLEAR MAGNETIC RESONANCE AND RELAXATION OF ^{31}P IN THE PARAMAGNETIC STATE OF UP–US SOLID SOLUTIONS. Kuznietz, Moshe (Argonne National Lab., Ill.); Baskin, Yehuda; Matzkanin, G. A. Phys. Rev.; 187: 737-47 (10 Nov 1969).

Measurements by continuous-wave and pulsed NMR were made on ^{31}P in the paramagnetic state of the UP–US solid solutions. All the $UP_{1-x}S_x$ compositions used have a NaCl-type structure, are good conductors of electricity, and show systematic changes in the paramagnetic Curie temperature θ and in the magnetic ordering, from type-I antiferromagnetic in UP to ferromagnetic in the US-rich compositions. Measurements were made of the Knight shift K, the linewidth ΔH, the Bloch decay time constant T_2^*, the echo decay time constant T_2, and the spin-lattice relaxation time T_1, as functions of temperature T and sulfur concentration x. K is linear in the molar susceptibility, $K = K_0 + (4.0 \pm 0.5)\chi_M$, with $|K_0| \ll K$, and with a slope independent of x and similar to the slopes of K versus χ_M for other U compounds with magnetic ordering. The changes in θ and in magnetic ordering along the $UP_{1-x}S_x$ system that could be accounted for by RKKY-type (Rudermann–Kittel–Kasuya–Yosida) interactions are not reflected in K, thereby disqualifying the RKKY model for the Knight shift. The broad NMR lines are due to inhomogeneous effects in the powder samples (demagnetization and composition variation), and both ΔH and T_2^* are dominated by inhomogeneous magnetic fields. The spin-spin relaxation time T_2', deduced from T_2, is due mainly to homogeneous internuclear dipolar interactions. T_1 increases with temperature for all compositions, regardless of the magnetic ordering. T_1T is empirically related to K differently in the antiferromagnetic compositions ($T_1TK^2 \cong$ const) and in the ferromagnetic compositions ($T_1TK \cong$ const). The T_1 results are analyzed in terms of recently proposed models for nuclear relaxation due to indirect interactions with localized magnetic moments via the conduction electrons. (auth)

10646 LOCAL MOMENT FORMATION IN DILUTE ALLOYS. Brog, K. C.; Jones, Wm. H. Jr. (Battelle Memorial Inst., Columbus, Ohio). Phys. Rev. Lett.; 24: 58-61(12 Jan 1970).

^{59}Co NMR of Co impurities dissolved in Nb–Mo and Ti–Mo hosts is used to provide the first direct evidence in support of the Jaccarino–Walker hypothesis that moment formation in binary hosts is a discontinuous process in which the impurity moment is either zero or a fixed, maximum value depending upon the local atomic environment. (auth)

Theoretical Physics

Refer also to abstracts 10810, 10822, 10830, and 10835.

10647 (CERN-Bib-8) CATALOGUE OF REPRINTS OF SCIENTIFIC PAPERS IN THE PAULI COLLECTION. (European Organization for Nuclear Research, Geneva (Switzerland)). 1969. 470p. Dep. CFSTI (U. S. Sales Only).

This catalogue lists all the reprints in Pauli's collection. His own filing order has been conserved and all reprints are numbered in this sequence (10544). Each reprint is filed under the name of one of its authors and cross references are given for all co-authors. (W.D.M.)

10648 (IFA-FT-75) RELATIVISTIC SCHROEDINGER EQUATION FOR A PARTICLE WITH ARBITRARY SPIN. [PART] II. Ionesco-Pallas, Nicholas J. (Academia R. S. R., Bucharest. Institutul de Fizica Atomica). 1969. 18p. Dep. CFSTI (U. S. Sales Only).

The relativistic Schroedinger equation formerly derived by the author is generalized in order to include simultaneously vectorial, scalar, pseudo-vectorial, and pseudo-scalar interactions, without leaving the irreducible (2S+1) representation. For this purpose, a new approach to the theory, which deals with bilinear forms and the Lagrange function is adopted. Poincaré algebra and, consequently, the classical integrals of motion may be easily obtained by going over to the 2(2S+1) dimensionality. The possibility of nonlinear extension of the wave equation is investigated as well. Finally, it is pointed out that relativistic and probabilistic quantum mechanics for a particle with arbitrary spin would be possible without using redundant components, if the gyromagnetic ratio g is assumed g = 2, irrespective of spin and interation. (auth)

10649 COLLOQUE NATIONAL DE PHYSIQUE THEORIQUE. EXPOSES GENERAUX SUR DES SUJETS D'ACTUALITE, MARSEILLE, 19–22 AVRIL 1967. (National Conference on Theoretical Physics. General Exposition on Contemporary Subjects, Marseille, April 19–22, 1967). Colloque National de Physique Theorique. Paris; Centre National de la Recherche Scientifique (1969). 144p. (CONF-670459).

The conference included eight papers. Separate abstracts were prepared for three papers. Other papers not abstracted were on denaturation of deoxyribonucleic acid, optical coherence, C* algebras, the foundations of statistical mechanics, and relaxation of excited atomic states for collisions in a vapor. (J.F.P.)

For abstracts of individual papers see: 10252, 10791, and 10851.

10650 SPATIAL DIFFERENCING OF THE TRANSPORT EQUATION: POSITIVITY VS. ACCURACY. Lathrop, K. D. (Los Alamos Scientific Lab., N. Mex.). J. Comput. Phys.; 4: 475-98(Dec 1969).

Positive spatial difference schemes for the Boltzmann equation are derived and compared in x–y geometry. It is found that none of the positive schemes are as accurate as the most commonly used nonpositive scheme. A variable-weighted difference scheme in which the weights are chosen depending on the space-angle mesh is shown to give results similar to those obtained with difference schemes based on the method of characteristics. A version of the variable-weight scheme in which weights depend not only on the space-angle mesh but also on particle sources and fluxes is suggested as a means of obtaining the highest accuracy consistent with a positive difference scheme, but it is noted that such schemes are computationally more expensive than available corrective recipes used in conjunction with nonpositive schemes. (auth)

10651 BLOCH FUNCTIONS OF A RELATIVISTIC CHARGED PARTICLE IN A MAGNETIC FIELD. Malkin, I. A.; Man'ko, V. I. (Lebedev Inst. of Physics, Moscow). Dokl. Akad. Nauk SSSR; 188: 322-5(11 Sep 1969). (In Russian).

For nonrelativistic, spin-free charged particles in a constant and uniform magnetic field, the magnetic translational symmetry of the Hamiltonian makes it possible to obtain solutions which yield an irreducible representation of the magnetic translation groups. These solutions are analogs of Bloch functions. Calculations were carried out to prove the existence of such magnetic translational symmetries for relativistic Dirac particles within a magnetic field and to derive a Bloch-type quasi-periodic solution for them. These functions are suited for studying certain physical phenomena in semiconductors and semimetals within the framework of the two-zone models. The obtained derivations for magnetic translations are complex, but the results of studies by H. J. Fischbek, E. Brown, and J. Zak on the nonrelativistic equation may be applied for the Dirac equation. (TTT)

PHYSICS (HIGH ENERGY)

Particle Interactions and Properties (Experimental)

Refer also to abstract 10790.

Electromagnetic

Refer also to abstract 10835.

10652 (DESY-69/46) SEPARATION OF σ_l AND σ_t IN THE REGION OF DEEP INELASTIC ELECTRON-PROTON SCATTERING. Albrecht, W.; Brasse, F. W.; Dorner, H.; Flauger, W.; Frank, K. H.; Gayler, J.; Hultschig, H.; Korbel, V.; May, J.; Ganssauge, E. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Nov 1969. 7p. Dep. CFSTI (U. S. Sales Only).

From the recent SLAC and DESY data on inelastic e-p scattering σ_l and σ_t were separated for momentum transfers of 0.8 and 2 $(GeV/c)^2$. It is found that the contribution of σ_l to the cross section is small. (auth)

10653 (DESY-69/48) A NEW MEASUREMENT OF THE π^0 LIFETIME THROUGH THE PRIMAKOFF EFFECT IN NUCLEI. Bellettini, G.; Bemporad, C.; Braccini, P. L.; Bradaschia, C.; Foa, L.; Luebelsmeyer, K.; Schmitz, D. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Nov 1969. 17p. Dep. CFSTI (U. S. Sales Only).

A new measurement of the π^0 lifetime through the Primakoff effect on nuclei was performed at DESY. The π^0 photoproduction at small angles was measured on four elements (C, Zn, Ag, Pb) at two energies (1.5 GeV and 2.0 GeV). The final result for the lifetime is $\tau = (0.56 \pm 0.06) \cdot 10^{-16}$ sec. (auth)

10654 (JINR-E-1-4786) INVESTIGATION OF THE ELECTROMAGNETIC STRUCTURE OF π-MESON USING THE IHEP (INSTITUTE OF HIGH ENERGY PHYSICS) ACCELERATOR. Bardin, Yu. D.; Czyzewski, O.; Dobrowolski, T.; (and others). (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1969. Dep. CFSTI (U. S. Sales Only).

An experiment on investigation of the electromagnetic structure of the π-meson by studying the 50 GeV/c pion scattering by electrons is suggested. The experiment is performed using the filmless spark chambers on-line with a computer. Modeling is performed taking into account the real possibilities of the equipment used, the experimental errors are estimated and the radiative corrections are calculated. (auth)

10655 HIGH-ENERGY PHOTOMESON PRODUCTION FROM HYDROGEN VIA THE "U-CHANNEL." Gustavson, David Blair. Stanford, Calif.; Stanford Univ. 1969. 121p.

Thesis.

The photoproduction process $\gamma + p \rightarrow \pi^+ + N$ was investigated over the energy range 2.8 to 9.8 GeV at momentum transfers u from -0.5 to $+0.1$ $(GeV/c)^2$. The process $\gamma + p \rightarrow K^+ + \Lambda, \Sigma^0$ was investigated at 5, 10, and 15 GeV for $u = -0.3$ $(GeV/c)^2$. The electron beam from the Stanford Linear Accelerator Center (SLAC) was used to produce a high-energy bremsstrahlung photon beam which bombarded a liquid hydrogen target. The photoproduced mesons were momentum and angle analyzed by the SLAC 1.6-GeV/c spectrometer, and were identified by means of range, Cherenkov counters and time of flight. The cross section $d\sigma/du$ for $\gamma + p \rightarrow \pi^+ + N$ above 4 GeV varies approximately as $s^{-2.9 \pm 0.5}$, and shows very little structure. In particular, no dip is seen at $u = -0.2$ $(GeV/c)^2$, which indicates that the process is not dominated by nucleon exchange. (Diss. Abstr.)

10656 DEUTERON PHOTODISINTEGRATION NEAR THE FIRST NUCLEON RESONANCE. Sober, Daniel Isaac. Ithaca, N. Y.; Cornell Univ. (1969). 204p.

Thesis.

The angular distribution of deuteron photodisintegration in $\gamma + d \rightarrow n + p$ in the region of the first nucleon resonance was measured at the Cornell 2-GeV synchrotron, using a bending magnet and four magnetostrictive-delay-line wire spark chambers to detect the recoil proton. The cross section was measured at six laboratory angles between 24 and 130 degrees, using bremsstrahlung beams of 350 and 450 MeV maximum energy. The broad momentum acceptance of the spectrometer allowed data to be acquired simultaneously for all energies at each angle. Contamination from pion production and other processes was avoided by keeping the synchrotron energy low, and its absence was verified by comparing cross sections obtained at different synchrotron energies. The application of geometric cuts to the analysis calculation eliminated events in which the detected particle was scattered from the magnet poles. Approximately 400,000 events were recorded on magnetic tape and later analyzed, yielding cross sections with statistical errors between 2 and 6 percent at 20-MeV intervals of photon energy. Complete angular distributions were obtained between 240 and 320 MeV, covering the peak in the cross section due to the $\Delta(1236)$ resonance which occurs at approximately 275 MeV. A least-squares fit to the data was made, using the traditional form. (TSS) (Diss. Abstr.)

10657 A COMMENT ON THE PHOTO-EXCITATION OF THE ROPER RESONANCE. Berends, F. A. (Harvard Univ., Cambridge, Mass.); Donnachie, A. Contract AT(30-1)-2076. Phys. Lett.; 30B: 555-7(8 Dec 1969).

Recent data on the reaction $\gamma n \rightarrow \pi^- p$ are used to discuss the photoproduction of the P11 (1470). There is no indication that the photoproduction of the P11 (1470) is favored on a neutron as compared to production on a proton, thereby favoring the octet assignment of the P11 (1470). (auth)

10658 MEASUREMENT OF LIFETIME OF THE π^0 MESON. Kryshkin, V. I.; Sterligov, A. G.; Usov, Yu. P. (Tomsk Polytechnical Inst., USSR). Zh. Eksp. Teor. Fiz.; 57: 1917-22(Dec 1969). (In Russian).

The lifetime of neutral pions τ_{π^0} is measured by the Primakoff method. For this purpose the angular distribution of π^0 mesons produced by 1.1 GeV γ quanta in the Coulomb field of a lead nucleus is measured. The data yield the value $\tau_{\pi^0} = (0.90 \pm 0.068) \cdot 10^{-16}$ sec. (auth)

Weak

10659 (COO-1195-169) COMPARISON OF THE POSITIVE AND NEGATIVE TAU PRIME PARTIAL DECAY RATES FOR KAONS. Herzo, Dennis Paul (Illinois Univ., Urbana. Dept. of Physics). Oct 1969. Contract AT(11-1)-1195. 113p. Dep. CFSTI.

Thesis.

A scintillation counter-optical spark chamber arrangement was used with incident positive and negative 3.5-GeV/c beams at the Argonne National Laboratory Zero-Gradient Synchrotron to study τ' $(K^\pm \rightarrow \pi^\pm\pi^0\pi^0)$ decays. A difference between the τ'^- and τ'^+ partial decay rates $\Gamma(\tau'^-)/\Gamma(\tau'^+) \neq 1$ would indicate the presence of a CP-violating $\Delta I \geq 5/2$ weak amplitude for these decays. Furthermore, a difference between the sum of the τ^- and τ'^- decay rates and the sum of the τ^+ and τ'^+ decay rates $[\Gamma(\tau^-) + \Gamma(\tau'^-)]/[\Gamma(\tau^+) + \Gamma(\tau'^+)] \neq 1$ where $\tau^\pm$ represents $K^\pm \rightarrow \pi^\pm\pi^+\pi^-$ decays would indicate the presence of a CPT violation in these decays provided the electromagnetic interaction could be neglected. After small corrections for unavoidable asymmetries in the efficiencies were calculated and applied to the scanning results, it was found that $[\Gamma(K^- \rightarrow \pi^-\pi^0\pi^0)/\Gamma(K^+ \rightarrow \pi^+\pi^0\pi^0)] = 1.009 \pm 0.018$. Thus no indication of a CP violation was found in τ' decays. After combining this result with known results for the ratio of the τ^- to τ^+ partial decay rates and the τ and τ' partial decay rates themselves, it was found that $[\Gamma(\tau^-) + \Gamma(\tau'^-)]/[\Gamma(\tau^+) + \Gamma(\tau'^+)] - 1 = 0.0024 \pm 0.0045$. Therefore, no evidence for a CPT violation was found in these decays. (auth)

10660 (NEVIS-176) A TEST OF μ-e UNIVERSALITY FROM HIGH ENERGY MUON-PROTON ELASTIC SCATTERING. Camilleri, Leslie (Columbia Univ., Irvington-on-Hudson, N. Y. Nevis Labs.). 1969. Contract AT(30-1)-1932. 87p. (CU-280; R-674). Dep. CFSTI.

Thesis.

An experiment on muon-proton elastic scattering was performed at the Brookhaven AGS in the momentum transfer range $0.15 < q^2 < 0.9$ $(GeV/c)^2$. Negative muons at incident momenta 6, 11, and 17 GeV/c and positive muons at 6 and 11 GeV/c were studied. The analysis, based on 2000 events per incident momentum and sign, shows that within errors, μ-p elastic scattering has the same q^2 dependence as e-p elastic scattering (in the same q^2-range). The μ-p cross sections obtained are, however, 8% below the e-p ones in absolute magnitude. Using a form factor of the form $1/1 + q^2/\Lambda^2$ to account for the difference, a limit of $\Lambda > 2.3$ GeV/c is set at the 95% confidence level. (auth)

10661 DEPENDENCE OF ν-NUCLEUS CROSS SECTIONS ON THE MASS NUMBER. Borer, K.; Hahn, B.; Hofer, H.; Kriensen, F.; Seiler, P.-G. (CERN, Bern). Phys. Lett.; 30B: 572-5(8 Dec 1969).

High-energy ν-nucleus cross sections were compared for Pb, Fe, Al, and C as target nuclei, exposed to the CERN ν-beam. The

events with $\theta_{\mu_2} < 29°$ and $p_\mu \gtrsim 1$ GeV/c have rates in the ratio of the mass number of the nuclei. Also a restricted sample with $q^2 \lesssim 0.1$ (GeV/c)^2 and $\theta_{\mu_2} < 5°$ does not reveal a theoretically predicted deviation from A-proportionality, although due to the limited statistical accuracy in this restricted sample an "$A^{\frac{1}{3}}$-contribution" of several tenths cannot be excluded either. (auth)

10662 CONSEQUENCE OF HIGH-ENERGY NEUTRINO EXPERIMENT ON THE LEPTON NUMBER CONSERVATION LAW. Chang, C. Y. (Univ. of Maryland, College Park). Phys. Rev. Lett.; 24: 79-81(12 Jan 1970).

Using the quoted μ^+-to-μ^- ratio obtained from the Berne-CERN-Fribourg neutrino experiment, the upper limit of C_M was estimated to be of the order of $5C_V$, where C_V is the universal vector-coupling constant of β decay, and C_M characterizes the coupling strength of a four-fermion weak interaction vertex only allowed by a multiplicative lepton-number conservation law. (auth)

Strong (Baryon-Induced)

10663 (PPAR-18) DEUTERON-DEUTERON INTERACTIONS AT SIX LABORATORY MOMENTA FROM 680 TO 2120 MeV/c. Goshaw, A. T.; Oddone, P. J.; Bazin, M. J.; Sun, C. R. (Princeton-Pennsylvania Accelerator, Princeton, N. J.). 27 Aug 1969. Contract AT(30-1)-2137. 17p. Dep. CFSTI.

The elastic and total cross sections for deuteron-deuteron interactions at 680, 920, 1180, 1500, 1750, and 2120 MeV/c are presented. The data are compared with theoretical calculations and shown to be in qualitative agreement with predictions based on the Glauber multiple scattering formalism. In particular the existence of large angle deuteron-deuteron elastic scattering provides evidence for the "simultaneous" scattering amplitudes predicted by the Glauber theory. (auth)

10664 (RHEL/R-186) WIDE ANGLE ELASTIC PROTON-PROTON SCATTERING AT HIGH ENERGIES (DIFFRACTION OR REGGE POLES.). Sacharidis, E. J. (Rutherford High Energy Lab., Chilton (England)). Oct 1969. 40p. Dep. CFSTI (U. S. Sales Only). UK 5s. 6d.

The final differential cross sections of elastic proton-proton scattering at large angles and high energies which have been measured at CERN in the last few years are presented. One of the experimental arrangements is described, together with the data obtained. The data are compared with measurements of other laboratories, and a brief discussion is included on theoretical attempts to interpret the data. (auth)

10665 SEARCH FOR FRACTIONALLY CHARGED PARTICLES IN TERRESTRIAL SAMPLES. Cook, Dwight Dexter. Urbana, Ill.; Univ. of Illinois (1969). 63p.

Thesis.

A geophysical search was performed for fractionally charged particles (mainly q_1 quarks) in sea water and rock samples. The samples chosen were ten rock samples, which are believed to have been at the earth's surface for a long time, and two three-liter sea water samples. The samples were run through cation exchange columns to separate most of the material from particles of charge $\pm^2/_3$ and $\pm^1/_3$. The purified samples were then evaporated in an electron gun, which accelerated the negatively charged particles to a solid state detector. The pulse height spectra from the detector were scanned for peaks corresponding to particles of a charge between minus one and zero. No such particles were found. The concentration of q_1 quarks in the rock samples was $\gtrsim 10^{-23}$ quarks/nucleon and in the sea water samples was $\gtrsim 10^{-24}$ quarks/nucleon. (Diss. Abstr.)

10666 FOUR-BODY STRANGE-PARTICLE PRODUCTION IN PROTON-PROTON COLLISIONS AT 6 BeV/c. Klein, Stanley Lewis. Berkeley, Calif.; Univ. of California (1968). 125p.

Thesis.

An exposure of the LRL 72-in. liquid-hydrogen bubble chamber to 6 BeV/c protons has yielded some 3000 examples of production of strange particles in four-body final states. Cross sections for the reactions $pp \rightarrow \Lambda K^0 p\pi^+$, $pp \rightarrow \Lambda K^+ p\pi^0$, and $pp \rightarrow \Lambda K^+ n\pi^+$ are 64 ± 6 μb, 39 ± 6 μb, and 43 ± 4 μb, respectively. The resonances K*(890), N*(1236), and Y*(1385) are produced and cross sections are determined. In addition, the quasi-two-body reaction $pp \rightarrow NN^*(1950)$, $N^* \rightarrow Y^*K$ is observed. Except for the low $K\pi$ effective mass region, the data are found to be in good agreement with a pion exchange model. (Diss. Abstr.)

10667 NEUTRON-PROTON ELASTIC SCATTERING FROM 8 TO 30 GeV/c. Gibbard, Bruce G. (Univ. of Michigan, Ann Arbor); Jones, Lawrence W.; Longo, Michael J.; O'Fallon, John R.; Cox, Jack; Perl, Martin L.; Toner, William T.; Kreisler, Michael N. Phys. Rev. Lett.; 24: 22-5(5 Jan 1970).

The differential cross section for neutron-proton elastic scattering was measured in the diffraction region with incident-neutron momenta between 8 and 30 GeV/c. The experiment was a spark-chamber-counter experiment, conducted at the alternating-gradient synchrotron. Results are presented and compared with currently available lower energy np data and comparable energy pp data. (auth)

10668 INTERPRETATION OF THE (d,π) ENHANCEMENT AROUND 2.2 GeV/c^2. Evrard, D. (Centre de Recherches Nucleaires, Strasbourg); Fridman, A.; Hirshfeld, A. C. Nucl. Phys.; B14: 699-706(1969).

An attempt is made to explain the (dπ) enhancement in production experiments. A final-state interaction is assumed which is treated as on-mass-shell pion-deuterium elastic scattering, using the first-order impulse approximation. Good agreement is obtained with the available experimental data. Two assumptions for the production mechanism lead to results consistent with the experimental values for a specific example of $\bar{p}d \rightarrow \bar{p}d\pi^+\pi^-$ reaction at 5.55 GeV/c. (auth)

10669 FURTHER SEARCH FOR QUARKS AT THE 70 GeV IHEP ACCELERATOR. Antipov, Yu. M.; Bolotov, V. N.; Devishev, M. I.; (and others) Inst. for High Energy Physics, Serpukhov, USSR). Phys. Lett.; 30B: 576-80(8 Dec 1969).

The results of the experiment searching for quarks with charge $-^1/_3$ and $-^2/_3$ produced by 70-GeV protons on an aluminum target set at zero angle are reported. For the selection of quarks the system of spectrometric scintillation counters, time-of-flight spectrometer, gas Cherenkov threshold counter and magnetic spectrometer with spark chambers were used. In the range of masses available at the IHEP accelerator, quarks were not found. The upper limit estimation of the differential cross section for quark production with mass ≤ 5 GeV/c^2 and charge $-^1/_3$ is 7×10^{-38} cm^2/ster GeV/c (with 90% confidence level). The total cross section for quark production with charge $-^1/_3$ and mass 4.5 – 5 GeV/c^2 does not exceed 3×10^{-39} cm^2. (auth)

10670 SEPARATION OF SINGLE AND DOUBLE SCATTERING IN PROTON–DEUTERON COLLISIONS AT 19.2 GeV/c. Allaby, J. V.; Diddens, A. N.; Glauber, R. J.; Klovning, A.; Kofoed-Hansen, O.; Sacharidis, E. J.; Schluepmann, K.; Thorndike, A. M.; Wetherell, A. M. (CERN, Geneva). Phys. Lett.; 30B: 549-54 (8 Dec 1969).

Experimental data exhibiting the separation of single and double quasi-elastic scattering in proton–deuteron collisions at 19.2 GeV/c and for momentum transfers around 1 GeV/c are presented. An analysis of the scattering cross section in terms of the multiple scattering theory is given. The possibilities for the deduction of proton–neutron differential cross sections particularly at large momentum transfers are pointed out. (auth)

10671 ANGULAR DISTRIBUTION OF INTEGRATED HADRON FLUXES DUE TO 3 GeV PROTONS. Awschalom, M.; Schimmerling, W. (Princeton Univ., N. J.). Nuovo Cim.; 64A: 871-80(21 Dec 1969).

Specific activation induced in C, Al, S, In, cadmium-covered In as well as the effects on ^{6}Li and ^{7}Li thermoluminescent dosimeters were measured as a function of angle with respect to a well-collimated 3 GeV proton beam incident on iron and lead 3.18 cm long cubes. The results were analyzed and fitted with a formula of the form a exp $[-b\theta]$ + c with confidence limits greater than 99.9%. The value of b may be described by a power function of the threshold energy of the detector in question. (auth)

10672 FURTHER SEARCH FOR QUARKS AT THE 70-GeV PROTON SYNCHROTRON OF IHEP. Antipov, Yu. M.; Bolotov, V. N.; Vishnevskii, N. K.; (and others) (Inst. of High Energy Physics, Serpukhov, USSR). Yadern. Fiz.; 10: 976-87(Nov 1969). (In Russian).

Results are reported of an experimental search for quarks, i.e. particles with fractional charges $-^1/_3$ and $-^2/_3$, produced by 70-GeV protons on Al target in the forward direction. No quarks were detected in the mass region available with the IHEP machine. The upper bound for the production differential cross section is obtained to be $7(10)^{-38}$ cm^2/sterad·GeV/c for quarks with mass ≤ 5 GeV/c^2 and charge $-^1/_3$ (with 90% confidence level). The total production cross section for quarks with mass 4.5–5 GeV/c^2 and charge $-^1/_3$ is no more than $3(10)^{-39}$ cm^2. (auth)

10673 INELASTIC PION–NUCLEON AND COHERENT INTERACTIONS IN NUCLEAR EMULSIONS AT ENERGY 60 GeV. Anzon, Z. V.; Vinitskii, A. Kh.; Voinov, V. G.; Streltsov, I. S.; Takibaev, Zh. S.; Chasnikov, I. Ya.; Shakhova, Ts. I. (Inst. of Nuclear Physics, Alma-Ata, USSR). Yadern. Fiz.; 10: 991-8 (Nov 1969). (In Russian).

More than 2000 π^--meson interactions with nuclei are found on the 870 m of the primary tracks. The mean free path is found to be 39.4 ± 1.0 cm. There are 270 events of the inelastic pion-

nucleon interactions analyzed. The distribution is given of the secondary charged particle multiplicity n, the averaged multiplicity $\bar{n} = 6.6 \pm 0.2$. The angular characteristics of the secondary particles on $\lg tg\theta_{l.s.}$ and the asymmetry coefficient α is investigated as functions of the multiplicity. The mean free path for the coherent production of a pion pair is $\lambda = 24^{+7}_{-5}$ m, and of two pion pairs $-\lambda = 86^{+49}_{-25}$ m. It is found that the cross section of the coherent pion pair production is proportional to the primary particle energy. Distribution of the target effective masses is analyzed. A difference in the momentum spectrum of the protons from πp and πn interactions is observed. (auth)

Strong (Meson-Induced)

Refer also to abstracts 10759 and 10790.

10674 (COO-1195-177) PI-PLUS PI-ZERO PI-MINUS PRODUCTION IN K-MINUS PROTON INTERACTIONS AT 5.5 GeV/c. Chandler, Gerald David (Illinois Univ., Urbana. Dept. of Physics). Feb 1970. Contract AT(11-1)-1195. 123p. Dep. CFSTI.

Thesis.

The separated K^- beam and the 30-inch MURA hydrogen bubble chamber at the Argonne National Laboratory were used to obtain more than 400,000 stereoscopic photographs in which K^--proton interactions centered at a beam momentum of 5.46 GeV/c were recorded. From these photographs 2042 examples of the reaction $K^- p \rightarrow K^- p \pi^+ \pi^0 \pi^-$ were identified and studied. The following are the primary results of this study: The total cross section for the reaction is .6 ± .2 mb. The K^- in the final state tends to travel in the same direction as the beam K^- and the proton in the final state tends to travel (when considered in the overall center-of-mass) in the same direction as the target proton. Copious production of well known resonances occurs. In particular approximately 17% of the events have present an ω^0, 20% a K^{*0}, 10% a K^{*-}, 13% a Δ^{++}, and 13% a Δ^+. Other known resonances, including ρ, Δ^0, and Y*'s, are produced less copiously. As the result of the presence of these resonances there are numerous quasi-two, three, and four-body states. The quasi-three-body states Kωp, $K^{*-}\pi^-\Delta^{++}$, and $K^{*0}\pi^-\Delta^+$ were studied and found to be describable by a double peripheral model. An investigation of the $M_{\pi\pi\pi}$ spectrum leads to the conclusion that the $A_1(1070)$ is not produced in the data studied. (auth)

10675 (NEVIS-177) EXPERIMENTAL MEASUREMENT OF THE CHARGE ASYMMETRY IN THE DECAY $\eta \rightarrow \pi^+\pi^-\pi^0$. Stein, Stephen (Columbia Univ., Irvington-on-Hudson, N. Y. Nevis Labs.). 1969. Contract AT(30-1)-1932. 113p. (CU-281; R-682). Dep. CFSTI.

Thesis.

The reaction $\eta \rightarrow \pi^+\pi^-\pi^0$ was studied experimentally to determine whether or not a charge asymmetry exists. From a sample of 32,253 decays, an asymmetry of 1.66 ± 0.63% was measured. The final 3-pion state, if C is not conserved, is consistent with a mixture of I = 1 and I = 2 states. If the matrix element is written as 1 + ay + bx, where x and y are Dalitz plot variables, the real part of b was determined to be $2.45 \pm 0.75 \times 10^{-2}$. (auth)

10676 (ORO-2504-148) EVENT WEIGHTING AND CROSS-SECTIONS FOR THE 2.9 GeV/c K^-p EXPERIMENT. Technical Report No. 70-065. Hemingway, R. J.; Whiteside, H. (Maryland Univ., College Park. Dept. of Physics and Astronomy). Nov 1969. Contract AT(40-1)-2504. 46p. Dep. CFSTI.

A weighting procedure is applied to the hot events of the 2.9 GeV/c K^-p experiment to make a first-order correction for losses due to finite bubble chamber size, reduced efficiency in the detection of short decays and reduced efficiency in the detection of small angle kinks. The method is described in detail and pertinent particle distributions are presented. With due consideration of scanning efficiency, visibility factors, kinematic ambiguity and beam impurity, the cross sections of the many final states may be determined. (auth)

10677 (TID-25298) ELEMENTARY PARTICLE PHYSICS AT FLORIDA STATE UNIVERSITY. Progress Report, November 1, 1968–October 31, 1969. Lannutti, J. E.; Albright, J. R.; Colleraine, A. P.; Chandler, J. P.; Yost, G.; Williams, P. K.; Kretzschmar, M.; Kimel, J. D. (Florida State Univ., Tallahassee. Dept. of Physics). 20 Dec 1969. Contract AT(40-1)-3509. 19p. Dep. CFSTI.

Theoretical and experimental research on high-energy physics at the University of Florida from Nov. 1968 to Oct. 1969 is summarized. Publications issued during the period are also listed. (J.F.P.)

10678 (UCRL-19372) A STUDY OF THE REACTION $K^-N \rightarrow \Xi K$ FROM THRESHOLD TO 2.7 GeV/c. Muller, Richard A. (California Univ., Berkeley. Lawrence Radiation Lab.). 8 Aug. 1969. Contract W-7405-eng-48. 59p. Dep. CFSTI.

Thesis.

A partial wave analysis of the reactions $K^-p \rightarrow \Xi^-K^+$, $K^-p \rightarrow \Xi^0K^0$, and $K^-n \rightarrow \Xi^-K^0$ was performed. About 3000 events with beam momenta ranging from 1.2 to 2.7 GeV/c, obtained in the Berkeley 72 in. bubble chamber were used. New data are presented for the reaction $K^-n \rightarrow \Xi^-K^0$ at 2.1 and 2.64 GeV/c. The total cross sections at these momenta are $69^{\pm 14}_{\pm 8}$ μb and $36^{\pm 10}_{\pm 8}$ μb respectively. The polarization was measured from the sequential weak decays $\Xi \rightarrow \Lambda\pi$, $\Lambda \rightarrow p\pi^-$. By assuming that the parts of the invariant amplitudes that are due to baryon exchange factorize into functions that depend only on s = (total center of mass energy)^2 and u = (4-momentum of exchanged baryon)^2, powerful constraints are generated on the partial wave amplitudes. Using these constraints an energy dependent fit to the data was done. It is concluded from the fit that the data can be explained in terms of isotopic spin 0 baryon exchange, with small but important contributions from isotopic spin-1 baryon exchange and direct-channel resonance production. Only known Y* resonances were included in the direct channel. The baryon exchange partial waves move in counter-clockwise circles in the Argand diagram, suggesting that they may have a "dual" interpretation as resonant partial waves. (auth)

10679 LAMBDA-K^0 PRODUCTION CROSS SECTION: STRUCTURE NEAR THRESHOLD. van Dyck, Olin B. Philadelphia; Univ. of Pennsylvania (1968). 223p.

Thesis.

The reaction cross section for $\pi^- + p \rightarrow \Lambda + K^0$ was measured at six energies near threshold. A counter-spark chamber system allowed rapid collection of sufficient data to make the statistical errors small. A fully automatic measuring system, featuring the Penn HPD digitizer and computer track-finding, was used to analyze the pictures with uniform and known efficiency. The data were corrected for triggering bias and the cross sections were computed. The uncertainty in the overall normalization is 15%. The cross section is seen to reach a plateau from 838 to 913 MeV except for a narrow peak at 893 MeV. This disagrees with some earlier bubble chamber data; the significance and possible explanations of the difference in the experiments are considered. The shoulder in the cross section from 813 to 838 MeV, suggested by the earlier data, is also seen. Possible interpretations of the observed structure are given; it is believed that the structure is not easily explained in terms of known resonances or the cusp effect at Σ threshold. (Diss. Abstr.)

10680 PRODUCTION OF THREE CHARGED PIONS IN π^-p INTERACTIONS AT 5 BeV/c. Terreault, Bernard. Urbana, Ill.; Univ. of Illinois (1969). 168p.

Thesis.

The 72'' bubble chamber at the Lawrence Radiation Laboratory was exposed to a beam of 5-GeV/c π^- mesons and 150,000 photographs were taken. As a part of this experiment, the interactions producing four charged particles in the final states were measured and the reaction $\pi^-p \rightarrow p\pi^+\pi^-\pi^-$ was studied, with the emphasis placed on the three-pions system. The cross section for this reaction was found to be 1.80 ± 0.45 mb. For the final analysis 6300 events (0.286 ± 0.071 μb/event) were selected. The mass spectra of the different particle combinations were investigated The reaction was found to be characterized by the following features: strong production of well-known resonances, in particular the ρ^0 (35% of the events), N^{*++}_{1236} (30%) and various N^{*0}s; a broad enhancement in the $\pi^+\pi^-\pi^-$ and in the $\rho^0\pi^-$ mass between 1.0 and 1.4 GeV, associated with momentum transfers to the proton characteristic of diffraction-scattering. The data below the A_2 mass (1.26 GeV) are consistent with this enhancement being a state of spin-parity 1^+ with $J_z = 0$ along the incident pion direction. It does not appear to be entirely due to a Deck-type kinematic effect; three peaks of marginal statistical significance in the $\pi^+\pi^-\pi^-$ mass, with masses (and widths) 1.06 GeV (40 MeV), 1.17 Bev (60 MeV) and 1.475 GeV (30 MeV); peripheral production of a meson of mass 1.62 BeV, width about 100 MeV, decaying into $\pi^+\pi^-\pi^-$, and known as the A_3 meson. Its spin-parity is most probably 2^-. (Diss. Abstr.)

10681 A STUDY OF PION–PION INTERACTIONS FROM 7-GeV/c π^-p. Oh, Benedict Youngsoo. Madison, Wis.; Univ. of Wisconsin (1969). 240p.

Thesis.

From an analysis of a total of 15,000 events (370,000 pictures) of the reactions $\pi^-p \rightarrow \pi^-\pi^+n$, $\pi^-\pi^0p$, $\pi^-\pi^+\pi^-\pi^+n$ and $\pi^-\pi^+\pi^-\pi^0p$ at 7 GeV/c, the $\pi\pi$ scattering, elastic and inelastic was studied, up to a dipion invaraint mass of 2 GeV, together with the nucleon pole terms of the diffraction dissociation processes. It is found that at high $\pi\pi$ mass (above 1.5 GeV) the $\pi\pi$ scattering is predominantly diffractive and thus largely inelastic, while at low

$\pi\pi$ mass, S, P, and D wave amplitudes dominate the $\pi\pi$ scattering. The ρ and f mesons are analyzed in detail in the framework of the absorption modified one pion exchange model. And the spin-parity of the g meson is determined ($J^P = 3^-$) from its decay into 2π and 4π channels. The production and decay of the ρ^0 is quantitatively described by the absorption model, when the extended structure of the nucleon is taken into account. The ρ^- requires ω exchange in addition to π exchange. A significant amount of interference with the diffraction dissociation processes is seen to be present in the ρ region. A phase shift analysis in the region $1 \sim 1.5$ GeV of dipion mass is given and the total and elastic $\pi\pi$ scattering cross sections given up to 2 GeV of dipion mass. The analysis suggests the f meson to be partially inelastic; and the anomaly of the angular distributions in the 1.1–1.2 GeV region of the dipion mass seems likely due to a P-wave amplitude. (Diss. Abstr.)

10682 ON THE INTERACTIONS OF 17.2 GeV π^- MESONS WITH EMULSION NUCLEI. Kohli, J. M. (Panjab Univ., Chandigarh, India). Nucl. Phys., B14: 500-6(1969).

260 m of track length was followed and 631 interactions were picked up. On the basis of the effective target mass M_T, these events were divided into pure pion-nucleon and pion-multinucleon interactions. The behavior of various parameters like mean multiplicity, median angle, transverse momentum, energy in lab and c.m. system and coefficient of inelasticity was studied for these two types of events. The study of heavy tracks is useful in understanding the mechanism of nuclear disintegration. The original picture of the internuclear cascade model requires some further modifications in the light of an effect called "trailing." (auth)

10683 FURTHER STRUCTURE IN K^+N, I = 0 TOTAL CROSS SECTION. Abrams, R. J.; Cool, R. L.; Giacomelli, G.; Kycia, T. F.; Li, K. K.; Michael, D. N. (Brookhaven National Lab., Upton, N. Y.). Phys. Lett.; 30B: 564-7(8 Dec 1969).

A re-analysis of the available data on K^+N total and partial cross sections near 1 GeV/c gives evidence for the presence of a very broad elastic structure in the I = 0 state with mass 1780 MeV and width 565 MeV. (auth)

10684 EMISSION OF STRANGE PARTICLES TOGETHER WITH HYPERFRAGMENTS IN THE INTERACTION OF K^- MESONS OF 1.5 GeV/c WITH EMULSION NUCLEI. Todorovic, Z.; Juric, M. (Inst. of Physics, Belgrade). Phys. Lett.; 30B: 568-71(8 Dec 1969).

In the analysis of 308 stars with hyperfragments, 15 events were found in which, beside the hyperfragment, a strange particle was also identified. The origin of these events is discussed. (auth)

10685 COULOMB MULTIPLE SCATTERING OF PIONS WITH ENERGY 60 GeV. Voinov, V. G.; Chasnikov, I. Ya. (Inst. of Nuclear Physics, Alma-Ata, USSR). Yadern. Fiz.; 10: 988-90 (Nov 1969). (In Russian).

It is shown that the experimental value of the Coulomb multiple scattering constant K for 2 to 20 mm cells is systematically lower than the theoretical values. These K values are lower than those for traces of particles with energies up to 27 GeV. The mean-square value of the second difference for the Coulomb scattering as a function of the cell dimensions t is proportional to $t^{1.35\pm0.04}$. (auth)

10686 OBSERVATION OF BACKWARD η PRODUCTION. Chase, R. C.; Coleman, E.; Courant, H. W. J.; Marquit, E.; Petraske, E. W.; Romer, H. F.; Ruddick, K. (Univ. of Minnesota, Minneapolis). Phys. Lett.; 30B: 659-61(22 Dec 1969).

The production of η mesons was observed at high momentum transfer in the reaction $\pi^-p \to n\eta$. The ratio between this cross section and that for backward charge exchange yields a value for the relative couplings $g^2_{\eta NN}/g^2_{\pi NN}$. (auth)

10687 A BUBBLE CHAMBER STUDY OF THE REACTION $\pi^-p \to 2\pi^-2\pi^+n$ AT 6 GeV/c. Powers, Walter Edman. Bloomington, Ind.; Indiana Univ. (1968). 67p.

Thesis.

A study is made of the reaction $\pi^-p \to 2\pi^-2\pi^+n$. The center of mass energy of the interaction is 3.49 GeV. The data were obtained at the Argonne National Laboratory where the MURA hydrogen-filled bubble chamber was exposed to a beam of negative pions having a laboratory momentum of 6 GeV/c. It is demonstrated by studies of missing mass spectra that the $2\pi^-2\pi^+n$ final state is kinematically ambiguous with some events from the processes $\pi^-p \to 2\pi^-\pi^+pk\pi^0$, $k > 1$ and that these proton-bearing reactions cannot be removed from the data sample by standard methods. An anomalous peak in the center of mass system angular distribution of the positive pions reported in previous studies was observed and found to be associated with the contaminating proton events. No evidence is found for significant $\Delta^-(1236)$ production as reported in previous studies. A strong ρ^0 meson signal was observed in the $(\pi^-\pi^+)$ invariant mass spectrum and found to be associated with the processes $\pi^-p \to \rho^0N^{*0}$ (2650,Δ2420) where the associated isobars decay by the pion emission processes $N^{*0} \to N^{*1}\pi^1 \to n\pi^2\pi^1$. The daughter isobars for which evidence is found are: $N'^+(1470)$, $N'^+(1710)$, $\Delta^+(1950)$. The method developed for observing these processes involved determining Lorentz invariant phase space distributions for data samples obtained by imposing invariant mass cuts. This method is applicable to any process having three or more decay links connecting two or more known resonance states. (Diss. Abstr.)

10688 STRANGE-PARTICLE PRODUCTION IN 6.7-GeV/c π^-p INTERACTIONS. Dickinson, Martha. Boulder, Colo.; Univ. of Colorado (1969). 142p.

Thesis.

Strange particles produced in interactions of negative pions of 6.7 GeV/c beam momentum with protons are analyzed in 100,000 photographic exposures from the Argonne National Laboratory 30" hydrogen bubble chamber. Partial cross sections are measured, and resonance production is studied. The cross section for production of hyperons of strangeness −1 and of kaons is 2.4 ± 0.2 mb. (Diss. Abstr.)

10689 INELASTIC INTERACTIONS OF HIGH ENERGY π-MESONS WITH PHOTOEMULSION. Barashenkov, V. S.; Gudima, K. K.; Toneev, V. D. (Joint Inst. for Nuclear Research, Dubna, USSR). Acta Phys. Pol.; 36: 457-67(Sep 1969).

The intranuclear cascades, initiated in the photoemulsion by π-mesons with an energy from several dozens of MeV up to 20 GeV, were calculated by the Monte Carlo method. The laws of the energy and momentum conservation and diffuseness of the nuclear boundary are taken into account; the processes of pion production (in particular, multiple particle production) and the absorption of π-mesons by target nucleons are taken into consideration. Continuous energy dependence of the intranuclear $\pi-N$ and $N-N$ interaction parameters is taken into account by means of special polynomial expressions. The results of the calculation agree well with experiment at all the energies $T \lesssim 5$ GeV. At higher energies a disagreement (increasing with the increase of the energy) between the calculated and experimental characteristics of grey and black tracks is observed. In the previously carried out calculations this circumstance was disguised by inaccuracies due to the rather rough approximation of the low energy part of the intranuclear $\pi-N$ and $N-N$ interactions. The modifications which have to be introduced into the conventional intranuclear cascade model at the energy $T \gtrsim 5$ GeV, are discussed. (auth)

10690 ON TWO BODY CHANNELS IN THE INTERACTIONS OF NEGATIVE PIONS WITH PROTONS IN THE FEW GeV REGION. Tuli, S. K. (Banaras Hindu Univ., India). Proc. Indian Acad. Sci., Sect. A; 70: 140-9(Sep 1969).

A compilation on the reactions $\pi^-p \to \pi^-p$, $\pi^-p \to \rho^0n$ and $\pi^-p \to p^-\rho$ at nine laboratory momenta between 1.59 and 4.16 GeV/c is presented and certain common features of these channels brought out. Relevant basic parameters for production angular distributions are obtained and their values interpreted. It is found that the diffraction peaks do not shrink as the center of mass energy increases. (auth)

Particle Interactions and Properties (Theoretical)

General

Refer also to abstract 9696.

10691 (COO-264-532) THEORETICAL RESEARCH IN ELEMENTARY PARTICLE PHYSICS. Technical Progress Report. (Chicago Univ., Ill.). [Dec 1969]. Contract AT(11-1)-264. 22p. Dep. CFSTI.

A progress report is presented on elementary particle theoretical research at the University of Chicago from December, 1968 to December, 1969. Brief synopses of this research and a list of publications issued are given. (J.F.P.)

10692 (ITEF-700) ATLAS OF DISTRIBUTIONS. Baloshin, O. N.; Borodina, I. N.; Gokhfel'd, I. M.; Kolkunov, V. A.; Lapidus, A. M.; Meiman, N. N.; Nikolaevskii, E. S.; Nilov, A. F.; Petrukhin, V. N. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). 1969. 199p. (In Russian). Dep. CFSTI (U. S. Sales Only).

A computation of the distributions in the model of the phase

space volume with account taken of the resonances and the restrictions on the movement of particles is discussed. The most frequent types of distributions are reduced to the 1 – 2 fold integrals of phase volumes of some sets of particle-blocks. A description is given of use of programs composed in ITEF for computation of distributions and graphics of different distributions, computed using these programs. (auth)

10693 (NYO–3829-42) HIGH-ENERGY PHYSICS AT THE UNIVERSITY OF PITTSBURGH. Progress Report, December 1, 1968–December 1, 1969. Pratt, Richard H. (Pittsburgh Univ., Pa. Dept. of Physics). Nov 1969. Contract AT(30-1)-3829. 24p. Dep. CFSTI.

A progress report is presented on research in theoretical high-energy physics at the University of Pittsburg. The research is briefly summarized, and publications issued during the period are listed. (J.F.P.)

10694 NORMALIZATION CONDITION FOR THE EQUAL-TIME WAVE FUNCTION OF TWO-PARTICLE BOUND STATE. Faustov, R. N.; Khelashvili, A. A. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 10: 1085-8(Nov 1969). (In Russian).

The normalization condition for the equal-time wave function of a two-particle bound state, satisfying a quasi-potential equation, is deduced from the spectral representation of the two-time Green function for the two particles. The condition depends explicitly on the quasipotential form. (auth)

10695 GREEN FUNCTIONS IN THE THEORY OF LOCAL UNRENORMALIZABLE INTERACTIONS. Kolkov, M. K. (Joint Inst. for Nuclear Research, Dubna, USSR). Commun. Math. Phys.; 15: 69-82(3 Dec 1969).

The method suggested earlier for the description of unrenormalizable interactions of massless particles is generalized to the case of interactions of particles with nonzero rest mass. (auth)

10696 HIGH ENERGY PHYSICS INDEX. VOLUME 7, NO. 23, 1969. Frankfurt am Main; Zentralstelle fuer Atomkernenergie-Dokumentation (1969). 59p.

10697 RELATIVISTIC EFFECTS OF STRONG BINDING ON SLOW PARTICLES. Katz, Amnon (Weizmann Inst., Rehovoth, Israel). J. Math. Phys. (N. Y.); 10: 2215-19 (Dec 1970).

The relativistic effect of strong binding on the equations of motion of slow particles is derived by taking the appropriate limit of the classical relativistic equations of motion of interacting particles. The expected effect on the total mass of the system is verified. The relative motion is also affected—in a model-dependent way. (auth)

Electromagnetic

Refer also to abstracts 9668, 9691, 10808, 10816, and 10906.

10698 (INSJ–112) A CASCADE THEORY UNDER APPROXIMATION C. Misaki, Akeo (Tokyo Univ. (Japan). Inst. for Nuclear Study). 10 Nov 1969. 11p. Dep. CFSTI (U. S. Sales Only).

A cascade theory is developed under approximation C. We shall call "approximation C" the approximation in which one considers a collision process and the Compton effect and uses a more precise formula instead of an asymptotic one to describe the radiation process and pair production. Analytical expressions are given. (auth)

10699 (NYO–2262-TA-198(Rev.)) ELECTROMAGNETIC MASS DIFFERENCE OF ZERO MASS PIONS: 4th ORDER. Gerstein, Ira S. (Massachusetts Inst. of Tech., Cambridge); Schnitzer, Howard J. (Brandeis Univ., Waltham, Mass. Dept. of Physics); Wong, Tang-Fong; Guralnik, G. S. (Brown Univ., Providence, R. I. Dept. of Physics). Nov 1969. Contracts AT(30-1)-2098; AT(30-1)-3178. 37p. Dep. CFSTI.

The fourth-order contribution to the electromagnetic mass difference of zero-mass pions is considered in a model whose high-energy behavior is that given by algebras of fields commutation relations. It is found that this quantity is logarithmically divergent. Possible sources of this divergence are discussed. (auth)

10700 (SLAC-Trans–102) HIGH-ENERGY INTERACTIONS OF GAMMA QUANTA AND ELECTRONS WITH NUCLEI. Gribov, V. N. Translated by R. Addis for Stanford Linear Accelerator Center, Calif., from paper presented at 4th Winter Seminar on the Theory of the Nucleus and the Physics of High Energies, Leningrad, USSR, February 5–17, 1969. 40p. (CONF-690217–1). Dep. CFSTI.

It is shown that the character of the interaction of photons and neutrinos with nuclei and the development of surface effects at high energies have no relation with meson (ρ) or meson (π) dominance but are determined solely by which distances are significant in those interactions. It is shown that if the longitudinal distances are of the order of $\delta = P/\mu^2$ then the total cross section of gamma quanta with heavy nuclei can be expressed in terms of the hadron part of the Lehmann density of the photon Green function of the electron pair annihilation of hadron cross section. (J.F.P.)

10701 (SU–1206-207) INELASTIC e-p SCATTERING DATA AND A NEW PARTON MODEL. Gardiner, C. W.; Majumdar, D. P. (Syracuse Univ., N. Y. Dept. of Physics). Dec 1969. 10p. (NYO–3399-207). Dep. CFSTI.

A parton model with integrally charged partons and a minimum number of partons equal to four is proposed as an alternative to the quark-parton models. It is found to give an excellent fit to the experimental data presently available, showing the validity of the parton concepts. (auth)

10702 CONVERGENCE OF ELECTROMAGNETIC FORM FACTORS. Einhorn, Martin B. Princeton, N. J.; Princeton Univ. (1968). 134p.

Thesis.

The mathematical problem posed by the dispersion relation analysis of electromagnetic form factors is discussed in a general way, and the relevance of the mathematical theory of systems of singular integral equations is pointed out. A simple absorption model illustrating the utility of the methods is formulated and discussed in terms of the dynamics of the pion-nucleon system. Another model for determining the high-energy behavior of the discontinuities (imaginary parts) of the pion and nucleon form factors is developed using Regge-pole phenomenology. It is concluded that the mathematical theory of systems of integral equations is a promising analytical tool for discussing electromagnetic form factors and should provide a new, useful method for theoretical research. Specific suggestions for further investigations are discussed. Particular attention is directed throughout to the theoretical puzzle posed by the rapid convergence of experimental data on nucleon form factors at large momentum transfers, and the so-called superconvergent sum rules for form factors are interpreted. (Diss. Abstr.)

10703 RADIATIVE CORRECTION TO K_{l3}. Becherrawy, Tamer. Rochester, N. Y.; Univ. of Rochester (1969). 120p.

Thesis.

The radiative correction to Kl3 decay are studied. Contrary to what is done usually by introducing a cutoff as a regulation of the photon propagator, it is assumed that the strong interaction introduces a natural cutoff for the electromagnetic interaction in the ultra-violet region. The strong interaction is taken into account by the electromagnetic form factors of the hadrons for which the vector meson dominance model is assumed. The radiative corrections to both the vector and axial part of the weak interaction are estimated by considering the lowest one particle intermediate states. No divergence is encountered if the form factors are represented by a sum of vector mesons poles. The radiative correction to the Dalitz plot, the spectra of both Ke3 and Kμ3 is calculated numerically. In the Ke3 case a correction is found to the lifetime of the order of +2%, a value which is much larger than +0.45% previously calculated by Ginsberg and the possible reason of this difference is discussed. In the case of Kμ3 a radiative correction of the order of +0.4% to the lifetime is found. Also the radiative correction to the polarization in Kμ3 is calculated and found and the order of 1% over a large part of the energies configuration. The correction may be very large in some points of the Dalitz plot. The contribution of the axial part in the calculation is small. (Diss. Abstr.)

10704 SOME CONSEQUENCES OF THE SATURATION OF COVARIANT QUARK MODEL SUM RULES AND A MODEL OF CP VIOLATION IN THE WEAK INTERACTION. Patsakos, George. Stanford, Calif.; Stanford Univ. (1969). 223p.

Thesis.

Some further consequences of a model introduced recently by Fubini, Segrè, and Walecka are investigated. These authors obtained the largest generalization of the Adler–Weisberger sum rule, which can be derived by considering the algebra of the generators of U(12) in the framework of a quark model. By assuming these "good" sum rules to be saturated by a few low-lying particles and resonances, in a Lorentz covariant manner, a consistent solution was then obtained for coupling constants which, although it requires no assumptions regarding the composite nature of hadrons or any higher symmetry, incorporates many features of the static quark model and the higher symmetry groups. A high energy contribution to one of the sum rules appearing in the model is calculated, and it is shown that one can improve

the agreement with experiment while maintaining the desirable features of the original solution. It is then indicated how the vector meson-photon coupling constant can be obtained as a by-product of the consistency solution and, using this new value, electromagnetic meson decay widths are investigated. Reasonable agreement with experiment is found. The $N^* \rightarrow N\pi$ decay is used to illustrate the higher-symmetry results obtainable in this model and some other symmetry features of the solution are mentioned. Making use of a new result for the N^*N weak axial vector vertex low-momentum transfer N^* production by neutrinos on protons is then calculated. The quark currents underlying the model are considered in more detail. It is found that of the "good" currents, i.e., the currents whose charges lead to good sum rules, the dual tensor has the opposite behavior under CP from the vector, axial vector and tensor currents. This fact, coupled with the feeling that all of the good currents should appear in some physical Hamiltonian, is used to construct a model of the weak interaction which violates CP and T invariance. Including an additional (small) coupling of the tensor currents to the four dimensional curl, $W_{\mu\nu}$, of a weak vector boson, an effective current-current interaction is obtained which, in addition to the usual Cabibbo vector and axial vector currents contains the divergences of the tensor and dual-tensor currents. Using the model Hamiltonian, the T violations which it predicts in nucleon and hyperon beta decay, K_{l3} decay, muon decay and high energy neutrino reactions are then investigated. Since only the good currents are used, one is in a position to compute the strong interaction renormalization effects in semi-leptonic processes from the sum rules, just as in the Adler–Weisberger relation. The model thus provides an unambiguous gauge of the relative sizes of the effects to be expected in these reactions. Experimental limits on the size of T violation allow one to place limits on the magnitude of the single parameter occurring in the theory. A crude estimate of the $K^0 \rightarrow 2\pi$ decay is then used to check the consistency of the approach. It is found that for values of the CP violating parameter of the order of 10^{-2}–10^{-3} the results do not contradict any existing experimental information. Using a reasonable value of the parameter in the results for the relative magnitudes of the effects in leptonic and semileptonic reactions, it is concluded that, although the effects are largest in the neutrino reactions and in several hyperon beta decays, when one takes into account the current state of experimentation, the most probable place for a T violation to be first observed experimentally is in the $K_{\mu 3}$ decay where the predicted effect is only one order of magnitude below the current experimental limit. (Diss. Abstr.)

10705 ON SOME CHARACTERISTICS OF TRANSITION RADIATION IN THE CASE OF OBLIQUE INCIDENCE OF RELATIVISTIC CHARGED PARTICLES. Korkhmazyan, N. A.; Elbakyan, S. S. (Inst. of Physics, Erevan. Erevan State Univ.). Izv. Akad. Nauk Arm. SSR, Ser. Fiz.; 4: 3-7(1969). (In Russian).

Calculations were made to investigate some characteristics of transition radiation in the case of oblique incidence of the charged particles in optical region and above it. (auth)

10706 AXIAL-VECTOR FORM FACTOR OF NUCLEON DETERMINED FROM THRESHOLD ELECTROPION PRODUCTION. Nambu, Yoichiro; Yoshimura, Motohiko (Univ. of Chicago). Phys. Rev. Lett.; 24: 25-8(5 Jan 1970).

Currently available electropion-production data near threshold were analyzed according to the soft-pion theorem which expresses the threshold cross section in terms of the vector and axial-vector form factors of the nucleon. The axial-vector form factor for q^2 up to ~7 $(GeV/c)^2$ was determined. (auth)

10707 A REGGE POLE ANALYSIS OF SOME RESONANCE PRODUCTION AND PHOTOPRODUCTION PROCESSES RELATED BY FACTORISATION. Devenish, R. C. E. (Univ. of Lancaster, Eng.). Nucl. Phys.; B14: 639-82(1969).

The following reactions were investigated using a simple Regge-pole model, $p\bar{p} \rightarrow \Delta\bar{\Delta}$, $pp \rightarrow \Delta N$, $\pi p \rightarrow \rho\Delta$, $\pi p \rightarrow \omega\Delta$, $Kp \rightarrow K^*(1400)$ N, $\gamma p \rightarrow \pi N$, $\gamma p \rightarrow \pi\Delta$, $\gamma p \rightarrow \rho p$, and $\gamma p \rightarrow \omega p$. The questions most concerned with are: (i) Can factorization be used successfully to relate the parameters in different processes? (ii) Is energy dependence consistent with kinematic behavior? (iii) Can a detailed fit to the data clarify the behavior of the Regge residue at t = 0, in particular, does the pion prefer conspiracy or evasion? (auth)

10708 VECTOR-MESON DOMINANCE AND DIFFRACTIVE ELECTROPRODUCTION OF VECTOR MESONS. Fraas, H. (Univ., Wuerzburg, Ger.); Schildknecht, D. Nucl. Phys.; B14: 543-65(1969).

A vector-meson dominance model of diffractive electroproduction of vector mesons at high energies is presented. The assumption that the invariant amplitudes are slowly varying as a function of the vector-meson mass, when extrapolating to the spacelike region, is shown to lead to serious difficulties when combined with helicity independence, i.e., equality of transverse and longitudinal on-mass-shell vector-meson forward-scattering helicity amplitudes at high energies. The assumption is adopted, therefore, that the helicity amplitudes are slowly varying, apart from the factors which guarantee the vanishing of the longitudinal amplitudes in the limit of zero mass. Assuming, in addition, helicity non-flip and helicity independence for vector-meson scattering, expressions are derived for the cross section for electroproduction of vector mesons and for the vector-meson spin-density matrix elements. Conclusions on the total electroproduction cross section are presented. (auth)

10709 BROKEN SCALE INVARIANCE AND ASYMPTOTIC SUM RULES. Ciccariello, S.; Gatto, R.; Sartori, G.; Tonin, M. (Univ., Padua). Phys. Lett.; 30B: 546-8(8 Dec 1969).

Current commutators relevant to the derivation of asymptotic electroproduction and neutrinoproduction cross sections and to the divergences in electromagnetic mass-shifts are specified in a theory of broken scale invariance and their physical consequences are derived. (auth)

10710 FIXED-s SUPERCONVERGENCE RELATIONS IN COMPTON SCATTERING AND SUM RULES. Mani, H. S.; Yao, York-peng (International Atomic Energy Agency, Trieste, Italy). Nuovo Cim.; 64A: 900-4(21 Dec 1969).

Certain fixed-s superconvergence relations in Compton scattering were saturated with baryons and resonances to obtain relations between their magnetic and transition moments. The results are strongly dependent on the saturation hypothesis, as in any other calculation of this sort, such as those which are based on fixed-t superconvergence relations. Since it is not clear which set should be saturated faster, a priori, it would be interesting to compare them independently with experiment. (auth)

10711 MULTIPLE-SCATTERING CORRECTIONS TO PION PHOTOPRODUCTION. Benfatto, G.; Nicolo, F.; Rossi, G. C. (Univ., Rome). Nuovo Cim.; 64A: 1033-52(21 Dec 1969).

Following the idea of including in the scattering amplitudes absorptive or multiple-scattering corrections, a generalization of the Frautschi–Margolis model is proposed, in which, starting from Regge-pole exchanges, one generates multiple-scattering corrections in the form of Regge cuts. A detailed application of the model to the high-energy π photoproduction is given and numerical results are given both for polarized and unpolarized differential cross sections, which are in agreement with experimental data. (auth)

10712 ELECTROPRODUCTION OF NUCLEON RESONANCES IN THE REGION OF HIGH MOMENTUM TRANSFER. Kupsch, J.; Ruehl, W. (CERN, Geneva). Nuovo Cim.; 64A: 991-1013 (21 Dec 1969).

The $O_{3,1}$ analysis of electromagnetic-vertex functions was applied to the electroproduction of resonances. This amounts to an investigation of the $O_{3,1}$ Fourier transforms of matrix elements of the electromagnetic current between a single-nucleon state and a resonance. The restrictions on the analytic structure of these Fourier transforms due to parity and current conservation are first discussed. A pole in a Fourier transform corresponds to a definite term in the asymptotic expansion of the form factors in the domain where the momentum transfer is spacelike and large. This fact is exploited for a detailed study of the production of $\Delta(1236)$. For the nucleon resonances of isospin $\frac{1}{2}$ the "tower hypothesis" is made that one pole dominates simultaneously the form factors of all these resonances and the nucleon itself. This implies a constant value for the ratio of the production cross section vs. the electron-nucleon elastic cross section in the limit of large momentum transfers. (auth)

10713 THE REACTION $e^+e^- \rightarrow \pi^0 + \omega(\pi^+\pi^-\pi^0)$ AND THE ω–ρ–π COUPLING. Renard, F. M. (Departement de Physique Mathematique, Montpellier, France). Nuovo Cim.; 64 A: 979-84 (21 Dec 1969).

This reaction is shown to be particularly interesting for the determination of the ω–ρ–π coupling parameters (coupling constant and off-mass-shell dependence). Predictions are given for the total cross section, $(\pi^+\pi^-\pi^0)$ mass distribution and ω density matrix. (auth)

10714 ELECTROMAGNETIC MASS DIFFERENCES OF HADRONS. Buccella, F. (Univ., Rome. Istituto Nazionale di Fisica Nucleare, Rome); Cini, M.; De Maria, M.; Tirozzi, B. Nuovo Cim.; 64A: 927-53(21 Dec 1969).

Starting from the Cottingham formula, the problem of the $\Delta I = 1$ and $\Delta I = 2$ mass differences of the pseudoscalar and vector mesons, $(\frac{1}{2}^+)$ baryon octet and $(\frac{3}{2}^+)$ decuplet are examined in the framework of Harari's approach. The Born and the transition terms of all these particles are calculated using a "low frequency"

limit which comes essentially from the strong suppression of high q^2 values in the Cottingham integral due to the form factors; in this limit a "universal" relation is found between both the electric and the magnetic contributions of the Born terms to the two gauge-invariant parts of the forward spin-nonflip amplitude for the Compton scattering. The residue function of the A_2 Regge pole $\beta(q^2)$ is calculated via FESR for the Compton scattering of K-mesons. The application of FESR to (p−n) mass difference is critically examined. The connection with the residues of all the other particles is obtained with the use of the "universality" hypothesis for the coupling of A_2 Regge pole with mesons and baryons proposed by Cabibbo, Horowitz and Ne'eman. It is found that the inelastic terms thus evaluated give always a contribution of the right sign to the e.m. mass differences. The final numerical results are in striking agreement with experiment. (auth)

10715 DIRAC'S EQUATION IN A WEYL SPACE. Novello, M. (Centro Brasileiro de Pesquisas Fisicas, Rio de Janeiro). Nuovo Cim.; 64A: 954-60(21 Dec 1969).

Dirac's equation is written in a Weyl space by means of a quaternionic formulation of Weyl's geometry. The so-called minimal coupling of the electron with the electromagnetic field is an obvious consequence of this formalism. Mass and charge can be interrelated by an investigation of the theory of massless charged particles imbedded in a Weyl space. (auth)

10716 PROTON–PROTON BREMSSTRAHLUNG CALCULATIONS. Marker, D. (Michigan State Univ., East Lansing. Hope Coll., Holland, Mich.); Signell, Peter. Phys. Rev.; 185: 1286-94(20 Sep 1969).

Revised calculations of the cross section for the process P + P → P + P + γ are presented, using several models and various approximations. These are compared to the latest calculations of other authors. For the Hamada–Johnston potential, they are found to be in good agreement with the data, and with only a small discrepancy among authors. However, strong discrepancies are found with previously published values for the Tabakin and Bryan–Scott potentials and for the Feshbach–Yennie approximation. It is estimated that inclusion of the Coulombic interaction of the protons lowers most of the cross sections by 5–10%. (auth)

10717 RADIATIVE CORRECTIONS TO πe SCATTERING. Bardin, D. Yu.; Semikoz, V. B.; Shumeiko, N. M. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 10: 1020-33(Nov 1969). (In Russian).

Radiative corrections to the elastic πe scattering are calculated for the experiments where the energies and angles of either the recoiled electron or the recoiled pion are measured. It is shown that the contribution from the diagrams with two-photon exchange and from the diagrams describing the renormalization of the pion vertex is no more than 1% in the cross section and may be neglected. In this situation it is possible to determine the π-meson electromagnetic form factor from the cross section with the radiation corrections included. The essential role of the error in the measured angle is shown to be a consequence of the kinematics of the process. (auth)

10718 COULOMB COUPLING, GAUGE INVARIANCE, AND THE REGGE THEORY OF PHOTOPRODUCTION. Dombey, N. (Univ. of Sussex, Eng.). Phys. Lett.; 30B: 646-9(22 Dec 1969).

The special nature of the Coulomb coupling of a charged particle suggests that non-analytic terms are present in the Regge theory of photoproduction. This provides a natural explanation of the sharp forward peaks observed in charged pion photoproduction off nucleons. A high energy theorem for the forward photoproduction of pseudoscalar mesons follows. (auth)

10719 RADIATIVE EFFECTS AND THEIR ENHANCEMENT IN INTENSIVE ELECTROMAGNETIC FIELD. Ritus, V. I. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz.; 57: 2176-88(Dec 1969). (In Russian).

The radiative effects — photon mass, electron mass shift and anomalous magnetic moment of the electron — are considered in intensive electromagnetic field where they are functions of parameter $\chi = \sqrt{(eF_{\mu\nu}p_\nu)^2}/m^3$, proportional to the field and momentum of the particle. Effects become optimal at $\chi \sim 1$, e.g. at the field $4(10)^9$ Oe and energy 25 GeV. At higher energies photon mass square and electron mass shift increase as $\chi^{\frac{2}{3}}$ while anomalous magnetic moment decreases as $\chi^{-\frac{1}{3}}$. At $\alpha\chi^{\frac{2}{3}} \sim 1$ the exact theory of interaction with radiation field is necessary, which takes into account all radiative corrections. This region is more attainable than corresponding region of logarithmically large energies for radiative effects in vacuum. The obtained photon and electron elastic scattering amplitudes have an essential singularity at $\chi = 0$. (auth)

10720 THE ANGULAR DECAY DISTRIBUTIONS OF THE RESONANCES PRODUCED IN THE PHOTOPRODUCTION PROCESSES γB → VB AND γB → VB* BY THE QUARK MODEL. Gorczyca, B.; Hayashi, M. (Jagellonian Univ., Krakow). Acta Phys. Pol.; 36: 433-8(Sep 1969).

Applying the quark model of photoproduction, a number of relations are predicted between decay angular distributions of the resonances produced in the processes γB → VB and γB → VB* induced both by linearly polarized photons and by unpolarized photons. These relations are grouped into different classes depending on the assumptions required in their derivations and their covariant properties. It is shown that the knowledge of the cross section and decay angular distributions for the process γB → VB* induced by unpolarized photons makes it possible to predict the cross sections for the processes induced by linearly polarized photons as well as an asymmetry parameter. (auth)

10721 VECTOR DOMINANCE AND PRODUCTION OF $\pi^\pm$ MESONS BY POLARIZED PHOTONS AT HIGH ENERGIES. Achasov, N. N.; Shestakov, G. N. (Mathematics Inst., Novosibirsk, USSR). JETP Lett. (USSR) (Engl. Transl.); 10: 220-2 (5 Oct 1969).

Translated from Zh. Eksp. Teor. Fiz. Pis'ma Redaktsiyu; 10: 347-53(5 Oct 1969).

The relation between pion photoproduction on nucleons and the production of vector mesons in πN collisions is studied on the basis of the vector dominance model. It is noted that for each four-momentum transfer there is a reference frame in which this relation is satisfied. Regge models are used for meson (ρ) production, and an upper limit of unity is found for this relation. (J.F.P.)

10722 MULTIPLE SCATTERING IN THE QUARK MODEL OF K^+ PHOTOPRODUCTION. Dean, N. W. (Vanderbilt Univ., Nashville, Tenn.). Nuovo Cim., Lett.; 2: 663-6(11 Nov 1969).

It is investigated whether including the multiple-scattering corrections to additivity can alter the value of $r = A(\gamma p \to K^+\Sigma^0)/A(\gamma p \to K^+\Lambda^0)$ sufficiently to explain the discrepancy in the prediction of the additive quark model that r has a value of 1/27 and the experimental result. It is found that at higher energies the discrepancy cannot be satisfactorily resolved by this means. (J.F.P.)

10723 AGREEMENT BETWEEN THE EXPERIMENTAL DATA DESCRIBING THE ELECTROMAGNETIC FORM FACTOR OF THE PION. Shcherbin, Yu. P. (Leningrad State Univ.). JETP Lett. (USSR) (Engl. Transl.); 10: 217-20(5 Oct 1969).

Translated from Zh. Eksp. Teor. Fiz. Pis'ma Redaktsiyu; 10: 340-4(5 Oct 1969).

The analytic consistency of the meson (π) electromagnetic form factor is checked, and the range of variation of r_π is determined from previous experimental data. (J.F.P.)

10724 NEW SUM RULES FOR NUCLEONIC VERTICES. Love, A. (Univ. of Glasgow). Ann. Phys. (N.Y.); 55: 322-40 (Nov 1969).

Two new sum rules of the πNN vertex dispersed in the nucleon invariant energy are derived from the equal-time commutator of the nucleon field with the pion field. Using a simple algebra of fields lagrangian, the commutator of the electric-dipole operator with the nucleon current operator is determined and used to derive a sum rule for γNN vertex dispersed in the nucleon invariant energy. Together with other sum rules for the same vertices these new sum rules are used in model calculations of g_A and μ_1, the coupling of the Roper resonance, p_{11} (1470), to the photon–nucleon system. By considering other PBB vertices the F/D ratios for the couplings of the spin ½ baryon resonance octets to the pseudoscalar–meson–baryon system are calculated. (auth)

10725 THE INFLUENCE OF THE DENSITY EFFECT ON ELECTRON-INDUCED CASCADE SHOWERS IN WATER AND ALUMINUM. Beck, Harold L. (Atomic Energy Commission, New York). Nucl. Sci. Eng.; 39: 120-1(Jan 1970).

Using a previously developed Monte Carlo electromagnetic shower code, the longitudinal energy deposition by showers from 1 GeV electrons in water and aluminum were calculated and their results compared with experimental data. To assess the relative importance of the density effect in the energy deposition, the Monte Carlo calculation for water was repeated ignoring this effect. It is found that neglect of the density effect raises the energy deposition at small depths and lowers it at large depths by as much as 35% for the depth intervals studied. (J.F.P.)

Weak

10726 (JINR-E2-4791) DEEP INELASTIC LEPTON–HADRON SCATTERING AND PAIR PRODUCTION IN STRONG INTERACTIONS. Koegerler, R. F.; Muradyan, R. M. (Joint Inst. for Nu-

clear Research, Dubna (USSR). Lab. of Theoretical Physics). 1969. 21p. Dep. CFSTI (U. S. Sales Only).

The deep inelastic lepton (l-electron or muon) scattering on a hadron a(a-proton or neutron) when in final state the outgoing lepton and some hadron a' are detected $l + a \rightarrow l + a' +$ "anything" and "anything" indicates the sum over all other possible hadrons is investigated. The five structure functions for this process are connected with the electromagnetic current commutators. By means of crossing the connection with the process of lepton pair production in strong interactions $\bar{a}' + a \rightarrow l + \bar{l} +$ "anything" is found. A test of models for the constituents of the electromagnetic current is made using a very simplified quark model. (auth)

10727 ASPECTS OF CURRENT ALGEBRA THEORY AND APPLICATIONS. Mohanti, Ajit Kumar. Rochester, N. Y.; Univ. of Rochester (1969). 164p.

Thesis.

An investigation is made in detail, of the consequences of Gell-Mann's hypothesis regarding the algebra of weak hadron currents, considered as a transition operator algebra (TOA) between hadron states. A comprehensive review of the background of this new approach to hadron physics is given. In particular, considerable space is given to discussions on the partially conserved axial vector current (PCAC) hypothesis, which is immensely useful in the application of current algebra to soft pion emission processes. General methods are described for writing sum rules from current algebra for renormalized coupling constants in the weak and electromagnetic interactions of hadrons. The connection between current algebra and broken symmetry is also briefly discussed. Some important applications are considered, including applications of current algebra and PCAC to some rare decay modes and the effect of the vector form factor in the $K_{\rho 4}$ decay. Various attempts to compute corrections to soft pion formulas are discussed. A more formal development of current algebra is considered. The Fubini–Dashen–Gell-Mann sum rule investigated in detail, as it is the most general result that one can obtain from current algebra considering a four-point function. Its connection with the Regge pole theory is investigated utilizing the Khuri-representation for amplitudes. It is shown that it leads to a much clearer understanding of the connection between fixed-pole singularities in the angular momentum plane and current algebra sum rules. This method also leads to a better understanding of the superconvergence sum rules than is possible through the usual helicity formalism. (Diss. Abstr.)

10728 PHOTON DECAY RATE OF Σ^+ FROM UNSUBTRACTED DISPERSION RELATIONS. Papaioannou, Gregory Miltiades. Urbana, Ill.; Univ. of Illinois (1969). 67p.

Thesis.

Taking the viewpoint of unsubtracted dispersion relations integral representations are derived for the weak photon decay amplitudes F_1 and F_2. The integrals involve the magnetic and electric dipole amplitudes M_{1-} and E_{0+} of the photopion production. They also involve the pion-nucleon scattering phase shifts of the states P_{11}, P_{31}, S_{11}, and S_{31}. The integrals were carried out on a computer and the relative decay rate of $\Sigma^+ \rightarrow p\gamma$ to its total rate was found to be 0.71×10^{-3}, which is comparable with the latest experimental value $(1.9 \pm 0.4) \times 10^{-3}$. (Diss. Abstr.)

10729 CURRENT ALGEBRA, FIELD ALGEBRA, AND K_{l3} FORM FACTORS. Denardo, G. (Univ., Trieste, Italy); Komen, G. J. Nucl. Phys.; B14: 593-608(1969).

Current algebra is used to obtain relations among the K_{l3} form factors by means of saturating the appropriate charge-current commutator. The frame dependence of the saturation is discussed. Since the current algebra relations do not determine the form factors themselves it is shown how either the assumption of once subtracted dispersion relations or the use of field algebra commutators gives additional information which enables us to write an expression for the form factors. Finally a rough numerical estimate of the results is given. (auth)

10730 REALIZATION OF THE TOTAL EXPERIMENT ON THE β DECAY. Gaponov, Yu. V. (Inst. of Atomic Energy, Moscow). Yadern. Fiz.; 10: 1003-6(Nov 1969). (In Russian).

Realization of the total experiment on the β decay of the neutron and of composite nuclei is considered in view of the modern status of the problem. Analyzing the experimental data the bounds are obtained for the parameters that determine the β-interaction Hamiltonian in the most general form. (auth)

10731 CURRENT ALGEBRA AND EFFECT OF ELECTROMAGNETIC MASS SHIFTS ON ISOTOPIC RELATIONS IN K-MESON DECAYS. Dolgov, A. D. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz.; 10: 1007-19(Nov 1969). (In Russian).

The dependence of the $K \rightarrow 3\pi$ decay matrix elements on μ^2, the mass of a π meson, and on the electromagnetic masses of π and K mesons is found in framework of current algebra and partially conserved axial current hypothesis. The account of the terms $\sim\mu^2$ allows one to improve essentially the agreement of the theory with the experiment for the probabilities of the decays $K \rightarrow 3\pi$. The determination of the amplitude dependence on $\delta\mu^2$ and δm^2 makes it possible to eliminate the 10 to 20% theoretical ambiguity (according to the $\Delta T = 1/2$ rule) in ratio of the decay probabilities which is due to electromagnetic mass shifts. The ratios of the probabilities and the spectra slopes in the decays $K \rightarrow 3\pi$ and $K \rightarrow 2\pi$ are determined by three parameters. The assumption that the amplitude as a function of the meson mass satisfies the requirements of SU(3) symmetry at $m = \mu$, $SU(2)_\oplus$ SU(2) at $m = 0$ etc., is a new one as compared with conventional hypotheses. (auth)

10732 A MEASUREMENT OF THE LONGITUDINAL COMPONENT OF MUON POLARIZATION IN $K_{\mu 3}$ DECAY. Burris, Richard Ward. College Park, Md.; Univ. of Maryland (1968). 86p.

Thesis.

Decays of K^+ at rest were observed by counter-controlled spark chambers which were triggered on a charged secondary with a range greater than 10 gm/cm² of carbon and a velocity less than .78 c. This selected muons from the $K_{\mu 3}$ mode with $40 \leq T_\mu \leq 60$ MeV. The decay product was stopped and the subsequent decay into a positron was observed. The angular correlation between the directions of flight of the muon and its direction at the decay positron were analyzed for a muon polarization. Similar angular distributions were obtained for muons from $K_{\mu 2}$ and background events. The final sample contained 132 $K_{\mu 3}$ candidates, 29 background events and 170 $K_{\mu 2}$ events. The polarization found was $P = \pm 1.7 \pm 1.2$. This is consistent with a form factor ratio, $\xi = 0$. (Diss. Abstr.)

10733 DECAYS OF K AND η MESONS IN THE VENEZIANO MODEL. Greenberg, D. F. (Carnegie-Mellon Univ., Pittsburgh). Nuovo Cim., Lett.; 2: 635-8(11 Nov 1969).

The extent to which the agreement with experiment is obtained for the energy spectrum of the odd pion for both K and η decay in a test of the Veneziano model is investigated. (J.F.P.)

Strong (General)

Refer also to abstract 10707.

10734 (IFVE-STF-69-17) TWO-PARTICLE REACTIONS AT HIGH ENERGIES IN THE REGION OF OREAR TRANSFERS. Anisovich, V. V.; Khrustalev, O. A. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii). 1969. 14p. (In Russian). Dep. CFSTI (U. S. Sales Only).

If in case of large energies the processes run peripherally and multiperipherally, then in two-particle reactions in the Orear region, their behavior is as $\exp(-b_{p_\perp})$, and the constant has the following features: it is similar in the scattering charge-exchange backward scattering processes as well as in processes running with the exchange of nonzero quantum number in t-channel; in the processes $A + B \rightarrow C + D$ with the exchange of the nonzero quantum number in the t-channel $b = \min$. A comparison of these features with the experimental data is presented. (auth)

10735 (JINR-P2-4824) MASS SPECTRUM OF DI-MUON PRODUCED IN STRONG INTERACTIONS. Matveev, V. A.; Muradyan, R. M.; Tavkhelidze, A. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1969. 14p. (In Russian). Dep. CFSTI (U. S. Sales Only).

The process of muon pair production in a deep inelastic collision of two hadrons $a + b \rightarrow \mu^+ + \mu^-$ + "anything" is discussed. Using the vector dominance model the formulas for the dimuon effective mass spectrum were obtained. An approximate connection of the mass spectrum with the cross section of the off-mass-shell strong process $a + b \rightarrow$ "anything" is considered. (auth)

10736 KINEMATIC CONSTRAINTS ON HELICITY AMPLITUDES FOR ARBITRARY EXTERNAL MASSES. Holden, John Phillip. Madison, Wis.; Univ. of Wisconsin (1969). 211p.

Thesis.

A method is proposed for studying the kinematic singularity and zero structure of helicity amplitudes. Using previously known results on the kinematic singularities of individual parity-conserving helicity amplitudes (PCHA), the crossing matrix between PCHA with their kinematic singularities removed is written out. The crossing matrices presented previously are discussed in some detail and the correct crossing matrix is determined by elimination of the invariant amplitudes from the s- and t-channel helicity amplitudes for $\pi N \rightarrow \rho N$ to obtain the crossing matrix, in the manner used to discuss $\pi N \rightarrow \pi N$ crossing. In terms of

these analytic PCHA, the crossing matrix still retains some explicit pole type singularities at t = 0, pseudothresholds, and normal thresholds in the t-channel. The analyticity of the s-channel and t-channel PCHA and the explicit poles of the crossing matrix between the analytic PCHA then require that the residues of these singularities vanish. The vanishing residues constitute sets of kinematic constraints among analytic PCHA at t = 0, pseudothresholds, and normal thresholds. Unlike previous treatments, separation of the various normal and pseudothresholds and t = 0 is not assumed. As a result, the analysis presented is valid for arbitrary mass assignments. The concept of mass analyticity is introduced. This allows one to reduce the constraint equations to a simpler form. A set of constraints at the fermion normal threshold and the boson normal and pseudothresholds are presented for the arbitrary mass reactions with spin structure spin ½ spin ½ + spin 0 → spin ½ + spin 1. The (single) t = 0 constraint (for general masses) and the fermion pseudothreshold constraints then couple the above constraint equations. These equations contain all special-mass results found previously for this class of reactions. A generalized set of invariant amplitudes for vector meson production in spinor-pseudoscalar meson scattering is used to check the mass analyticity requirements and to verify the constraint equations. The method proposed is completely general and it can be applied to reactions with arbitrary masses and spins. The Reggeization problem is discussed in terms of the examples developed. The πN scattering is taken as a simple example and the procedure for more complex (higher spin) cases is discussed. The spin ½ + spin 0 → spin ½ + spin 1 problem is discussed using the leading term in a power series in s for the amplitudes. The amplitudes are written in terms of "invariant amplitudes" defined from the constraint equations in this construction. The advantages and disadvantages in terms of j-plane properties and s-t analyticity of invariant amplitudes are briefly discussed. (Diss. Abstr.)

10737 COMMENTS ON THE LETTER EVIDENCE OF QUARKS IN AIR-SHOWER CORES. Frauenfelder, Hans; Kruse, U. E.; Sard, R. D. (Univ. of Illinois, Urbana). Phys. Rev. Lett.; 24: 33-5(5 Jan 1970).

The "quark tracks" observed by McCusker and co-workers in cloud chambers can be explained by making reasonable assumptions about two processes: fluctuations in the number of droplets in a cloud-chamber track, and the relativistic rise of the ionization. However, before a firm conclusion can be drawn, more experimental data on the drop-count distribution of a large sample of tracks in the experiment are needed. (auth)

10738 LEVEL STRUCTURE OF DUAL-RESONANCE MODELS. Fubini, S.; Veneziano, G. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Nuovo Cim.; 64A: 811-40 (21 Dec 1969).

The level structure of narrow-resonance models with duality is considered. The multiparticle dual amplitudes recently proposed by several authors are used and the structure of the residue of each pole in what concerns its factorizability is studied. It is found that for each energy eigenvalue $E_n = \sqrt{s}_n$ the residue does indeed factorize in a finite number of terms (number of degenerate levels) and that this number increases with n like exp $[cE_n]$. The physical interpretation of this wild increase is found in the essential many body nature of models consistent with duality. The appearance of states with imaginary coupling follows easily from the covariant, four-dimentional approach that was taken and that insures absence of kinematical singularities. It is nevertheless found that a cancellation mechanism analogous to the one existing in Q.E.D. (Ward identities) occurs here too. Although the problem of a systematic cancellation of all ghosts in a realistic case was not solved, it is seen that the leading and most troublesome ghosts are indeed eliminated in this way. (auth)

10739 QUARKS IN QUASARS AND A FALSE ANALOGY. Kuchowicz, B. (Univ., Warsaw). Acta Phys. Pol.; 36: 1105-7 (Dec 1969).

Arguments are presented in favor of the suggestion that the split-up of nucleons into quarks is an endoenergic process, and cannot be regarded as the energy source for quasars. (auth)

10740 PERMUTATION SYMMETRY OF THREE TRIPLETS AND BINDING OF QUARKS. Krolikowski, W. (Inst. of Nuclear Research, Warsaw. Warsaw Univ.). Acta Phys. Pol.; 36: 1057-63(Dec 1969).

The idea of permutation symmetry of three triplets in the Han-Nambu model, taken together with the previously proposed saturation mechanism provided by a complex "quark charge," solves the problem of unwanted mesons in this model. (auth)

10741 ON S-TRANSFORMATION IN THE STRONG COUPLING THEORY. Exner, P. (Charles Univ., Prague); Tolar, J. Czech. J. Phys.; 19: 1480-5(1969).

The S-transformation in a unitary transformation accomplishing the main part of the diagonalization of the interaction Hamiltonian in strong coupling theories. For a compact symmetry group the action of the S-transformation on the integrals of motion is derived. (auth)

10742 HADRON–HADRON SCATTERING IN THE QUARK MODEL. Weiner, Richard M. (Univ., Bucharest). Stud. Cercet. Fiz.; 21: 1041-82(1969). (In Rumanian).

The independent quark model as a first approximation in the theory of multiple scattering, the choice of energy at which the comparison between theory and experiment should be made, corrections to additivity due to multiple scattering and numerical analysis are covered, also corrections to additivity for meson–baryon scattering in some particular cases, double-scattering effects in the proton–proton differential cross section, and large momentum transfer scattering in the factorization quark model. (auth)

Strong (Baryon No. = 0)

10743 (COO-264-522) THE MULTIPOINT VENEZIANO MODEL, GHOSTS, AND CHIRAL CONSTRAINTS. Waltz, Ronald E. (Chicago Univ., Ill. Enrico Fermi Inst.). Oct 1969. Contract AT(11-1)-264. 26p. (EFI-69-88). Dep. CFSTI.

Veneziano models are constructed for typical five-point spinless (no parity doubling) processes $\pi^+\eta\pi^-\pi^+\pi^-$ (abnormal parity) and $\pi^+\sigma\pi^-\pi^+\pi^-$ (normal parity). They are simple one "term" crossing symmetric forms with full Regge behavior, no negative mass squared ghosts, and further they obey soft pion theorems using realistic trajectory parameters and external masses. The four-point amplitudes implied by the five-point amplitudes are of the Lovelace $\pi^+\pi^-\pi^+\pi^-$ and the Blackman, Goebel and Wali $A^+_{1,2}\pi^-\pi^+\pi^-$ forms. Emphasis is placed on the normal parity process for which it is shown that chiral constraints and the absence of negative mass-squared ghosts suggest a natural form for the amplitude. An implicit π-A, bootstrap is found and testable predictions on the A, decay modes and strengths are made. (auth)

10744 (COO-264-531) TWO-PION DECAY MODE OF THE ω AND $\rho\omega$ MIXING. Sachs, Robert G.; Willemsen, Jorge F. (Chicago Univ., Ill. Enrico Fermi Inst. Chicago Univ., Ill. Dept. of Physics). Dec 1969. Contract AT(11-1)-264. 21p. (EFI-69-102). Dep. CFSTI.

Recent experiments reporting the 2π decay mode of the ω meson and its interference with that mode of the ρ meson are analyzed in terms of the propagator method for mixing of particle states. Both vector mixing and mass mixing are included and the energy dependence of the ρ width is explicitly taken into account. It is shown that the effect as observed in the reaction $e^+e^- \to \pi^+\pi^-$ can be accounted for in terms of available parameters. The consequent determination of the parameters makes possible an analysis of strong interaction phenomena of the same type, giving information on the relative phases of ω and ρ production amplitudes. This is applied to the $\rho-\omega$ interference observed in $\pi^+p \to \pi^+\pi^-\Delta^{++}$. Other experiments are suggested. (auth)

10745 (SU-1206-213) WHY η AND η' MIGHT HAVE THE SAME MIXING AS ϕ AND ω. Case, William (Syracuse Univ., N. Y. Dept of Physics). Oct 1969. 12p. (NYO-3399-213). Dep. CFSTI.

η and η' are assumed to have the same mixing as is usually attributed to ϕ and ω and the resulting implications are drawn using generally accepted methods. Such a mixing is shown to satisfy a linear Gell-Mann Okubo mass formula to about 5%. It is also shown to correctly predict the branching ratios of $\Gamma(A_2 \to \eta'\pi) : \Gamma(A_2 \to \eta\pi) : \Gamma(A_2 \to K\bar{K})$ via $SU(6)_W$, while the generally accepted mixing ($\cos\alpha = .98$ $\sin\alpha = \pm.18$) fails. Lastly, this mixing is used with a vector dominance model to obtain a value for the total width of η ($\Gamma(\eta)_{tot.}$) which is close to the accepted experimental value. With the same model the generally accepted mixing results in a value for $\Gamma(\eta)_{tot.}$ which is off by about a factor of 2. $\Gamma(\eta')_{tot.}$ is also calculated but both the proposed and generally accepted mixings give results which agree with the rather vague experimental data. (auth)

10746 BOOTSTRAP THEORY AND A CALCULATION OF PION–PION SCATTERING LENGTHS. Bookstein, Abraham. New York; Yeshiva Univ. (1969). 127p.

Thesis.

The idea that bootstrap dynamics might be the phenomenology of a theory of tightly bound fundamental particles is developed. After showing this to be valid for a simple case representations for inner products and matrix elements of the Hamiltonian for states expressed in terms of the physical particles are developed. The proof is based upon a special field theoretical model of scalar bosons and a φ^3 interaction. This representation is then used to discuss pion-pion scattering. The eigenstate of the Hamiltonian

is approximated as being in the subspace of Hilbert space that is spanned by two physical pions. A "Schroedinger equation" is found for the expansion function, and this equation is solved using perturbation theory. The perturbation approach is expected to be valid because of kinematic effects resulting from the ρ-meson spin. The scattering lengths for the pions are calculated. It is concluded that $a_0 = 0.2\ m_\pi^{-1}$, $a_1 = -0.1\ m_\pi^{-1}$ and that second order corrections are small. (Diss. Abstr.)

10747 RESONANCE EXTINCTION AND EFFECTS OF DRIVING FORCES IN FINAL STATE INTERACTIONS. Aitchison, I. J. R. (Dept. of Theoretical Physics, Oxford); Graves-Morris, P. R. Nucl. Phys.; B14: 683-98(1969).

The absence of the rho resonance in the $\pi^+\pi^-$ subsystem of the $\pi^+\pi^-\pi^-$ final state produced by $\bar{p}n$ annihilation has prompted the investigation of resonance extinction in final state interactions. Resonance extinction is shown to be a general feature of a simple dispersion theoretic model. The qualities of the two-particle amplitude necessary for the corresponding decay amplitude not to have resonance extinction are discussed. An important factor throughout is the structure of the vertex function, i.e., the decay amplitude with no final state interaction. Using explicit models of the two-particle amplitude and vertex functions with structure, the widespread conjecture due originally to Watson, that attractive forces enhance a decay amplitude, is examined. (auth)

10748 RESONANCE INTERPRETATION IN ARGAND DIAGRAMS. Halzen, F.; Minkowski, P. (Univ., Leuven, Belgium). Nucl. Phys.; B14: 522-30(1969).

A model is given providing an interpretation of the phase shift in a resonance region in terms of a Breit–Wigner pattern, displaced and rotated due to background effects. As an application the P_{11} πN phase shifts are studied in the $N^*_{11}(1400)$ region. (auth)

10749 UNCERTAINTIES IN TESTS OF LONG-RANGE CHARGE INDEPENDENCE. Breit, G. (State Univ. of New York, Buffalo). Nucl. Phys.; B14: 507-21(1969). (NYO–4022-7).

It is pointed out that the determinations of the pion-nucleon coupling constant g based on distant collisions in proton-proton and neutron-proton scattering employing pseudoscalar theory have questionable validity because the physical particles are not the idealized undressed particles to which the one-pion-exchange considerations really apply. In section 2 the arbitrariness of the usual pseudoscalar and pseudovector forms of the pion-nucleon interaction Hamiltonian is discussed in relation to the phenomenological description. Section 3 contains an estimate of the effect of considering the factor $(m_\pi/M)^2$ as charge independent, which amounts in effect to changing from the pseudoscalar to the pseudovector form, on the comparison of the pion-nucleon coupling constant as derived from N-N scattering with large values of orbital momentum quantum number. In section 4 questions bearing on the violation of short-range charge independence with special reference to the effect of ρ mesons and also the interconnection of the two kinds of charge independence in the treatment of N-N scattering data are briefly discussed. The bearing of the theories of electromagnetic mass differences on the possible breakdowns of charge independence in π-N interactions is briefly discussed. (L.B.S.)

10750 CHIRAL LAGRANGIAN AND VENEZIANO MODELS FOR $\eta\pi$ SCATTERING AND η' DECAY. Harun-ar Rashid, A. M. (International Atomic Energy Agency, Trieste, Italy). Nuovo Cim.; 64A: 985-90(21 Dec 1969).

The prediction of the Veneziano model about the pion and eta-meson mass degeneracy in the Adler limit is shown to follow also in the nonlinear effective Lagrangian theory including Gell-Mann–Oakes–Renner-type symmetry breaking. The X-meson decay is also studied in the Lagrangian theory and compared with the Veneziano-model calculation of Baacke, Jacob, and Pokorski. The parameter y in the latter calculation is shown to be of the same order of magnitude in the Lagrangian theory leading to a width of the X-meson of about 3 MeV. (auth)

10751 INCONSISTENCY OF INTERACTION BETWEEN THE GRAVITATIONAL FIELD AND THE TENSOR MESON FIELD. Aragone, C. (Univ. de la Republica, Montevideo). Nuovo Cim.; 64A: 841-70(21 Dec 1969).

The minimal and nonminimal interactions between the gravitational and tensor meson fields are studied by performing a canonical analysis, starting from a Lagrangian which verifies the Fierz-Pauli condition and meaning by minimal interaction terms coming from the replacement of the usual derivatives by the Riemannian covariant derivatives in the flat Lagrangian. The nonminimal interaction, however, takes into account terms coupling first-order derivatives of the gravitational field with mesonic currents. It is very well known that the assumptions of minimal gravitational interaction for the scalar mesons, photons and massive spin-½ fermions give consistent theories. However, in the present work, it is shown that both coupling schemes are inconsistent. (auth)

10752 VENEZIANO AMPLITUDE FOR FOUR SPINNING PIONS. Olive, D. I.; Zakrzewski, W. J. (Cambridge Univ., Eng.). Phys. Lett.; 30B: 650-2(22 Dec 1969).

A Veneziano formula for four spinning particles, previously obtained by factorization of many point functions, is modified in order to kill the spin 0 particles on the leading trajectories. The formula obtained may now refer to particles on the pion trajectory, and it is verified that it has Adler zeros when any one of the particles is spinless and soft. (auth)

10753 $\omega, \varphi \to 2\pi$ DECAYS IN A GAUGE-FIELD MODEL. Kimel, I. (Univ. of Michigan, Ann Arbor). Lett. Nuovo Cim.; 2: 826-30(11 Dec 1969).

Using a gauge-field Lagrangian the ratios $\Gamma(\omega \to 2\pi)/\Gamma(\rho \to 2\pi)$ and $\Gamma(\phi \to 2\pi)/\Gamma(\omega \to 2\pi)$ are calculated. (J.F.P.)

10754 STATISTICAL TENSORS FOR SPIN TWO MESONS. Muryn, B. (Inst. of Nuclear Tech., Krakow). Acta Phys. Pol.; 36: 451-5(Sep 1969).

The double statistical tensors necessary for the description of the joint production of a $\frac{3}{2}$ isobar and a spin-two meson are expressed in terms of the joint density matrix elements. The formulas are applicable for all the parities of the isobar and the meson. (auth)

10755 CONSTANT AND INCREASING TOTAL CROSS-SECTIONS AT LARGE BUT FINITE ENERGIES. Mickens, R. E. (Massachusetts Inst. of Tech., Cambridge). Nuovo Cim., Lett.; 2: 669-73(11 Nov 1969).

A description of elastic scattering is given where the total cross section at large but finite energy is either constant or is increasing toward its constant asymptotic value. The relations between particle and antiparticle total cross sections and the behavior of the corresponding phases in the forward direction are discussed. The processes $a + b \to a + b$ and $\bar{a} + b \to \bar{a} + b$, where a and b are spinless and $\bar{a}$ as the antiparticle of a are considered. Using Regge pole theory and exchange degeneracy the phases for (K^+p, K^-n) and (K^-p, K^-n) are predicted. (J.F.P.)

10756 QUASI-NUCLEAR LEVELS IN THE NUCLEON–ANTINUCLEON SYSTEM. Dal'karov, O. D.; Mandel'tsveig, V. B.; Shapiro, I. S. JETP Lett. (USSR) (Engl. Transl.); 10: 257-9(20 Oct 1969).

Translated from Zh. Eksp. Teor. Fiz. Pis'ma Redaktsiyu; 10: 402-6(20 Oct 1969).

It is proven that S states can exist in a nucleon–antinucleon system with a small binding energy compared with the nucleon mass. A potential which correctly describes the $N\bar{N}$ scattering is used to solve the nonrelativistic problem for bound states. It is found that closely lying meson resonances exist in the energy region from 1580 to 1880 MeV. They have a width of the order of several dozen MeV and are quasinuclear states of the $N\bar{N}$ system. (J.F.P.)

10757 ON A METHOD OF NUMERICAL SOLUTION OF EQUATIONS OF THE LOW TYPE. Barnev, P.; Denchev, R.; Peng, Kim Tse. Izv. Fiz. Inst. Aneb, Bulg. Akad. Nauk.; 19: 173-84(1969).

The system of a linear singular integral equation and a nonlinear algebraic equation is considered for $\pi + \pi$ interactions. Numerical solutions are given. (J.F.P.)

10758 THE FACTORIZATION THEOREM OF REGGE RESIDUES AND SPIN DEPENDENCE OF THE $p\bar{p} \to \Delta\bar{\Delta}$ AMPLITUDE AT HIGH ENERGIES. Fialkowski, K. (Jagellonian Univ., Krakow). Acta Phys. Pol.; 36: 341-4(Sep 1969).

The consequences of the factorization properties of Regge amplitudes on the spin dependence of the process $p\bar{p} \to \Delta\bar{\Delta}$ are discussed. The assumption that this process is dominated by the exchange of several trajectories with either natural or unnatural parity is shown to disagree with the existing data at 5.7 GeV/c primary momentum. (auth)

Strong (Baryon No. = 1)

Refer also to abstracts 10749 and 10838.

10759 (BNL–14222) EXPERIMENTAL TESTS OF (ρ,A_2) AND (K^*,K^{**}) EXCHANGE DEGENERACY IN FORWARD MESON–BARYON SCATTERING. Lai, Kwan Wu; Louie, James (Brookhaven National Lab., Upton, N. Y.). [1969] 39p. (CONF-691202–1). Dep. CFSTI.

From Regge-pole Conference, Irvine, Calif.

The idea of exchange degeneracy of vector and tensor meson Regge trajectories is investigated experimentally for several pairs of reactions related by s ⟷ u crossing. (auth)

10760 (SU-1206-215) A VENEZIANO MODEL FOR THE REACTION $\pi^- p \to \eta n$. Blackmon, Maurice L.; Wali, Kameshwar C. (Syracuse Univ., N. Y. Dept. of Physics). Nov 1969. 14p. (NYO-3399-215). Dep. CFSTI.

A Veneziano model is proposed for the reaction $\pi^- p \to \eta n$. This reaction is interesting since only the A_2 trajectory can contribute in the t-channel, and only $T = \frac{1}{2}$ trajectories appear in the s- and u- channels. The terms in this model are limited to those which have leading asymptotic behavior in two channels. The intimate connection between resonance parameters and both forward and backward cross sections is emphasized. (auth)

10761 ACCIDENTAL DEGENERACY IN THE BETHE–SALPETER EQUATION. Basu, Debabrata; Biswas, S. N. (Univ. of Delhi). J. Math. Phys. (N. Y.); 10: 2104-13(Nov 1969).

The Bethe-Salpeter equation for the bound state of the pion-nucleon system was studied in the ladder approximation; the propagation time of the exchanged nucleon is neglected. By using the two-component formalism, the spinor equation is first reduced to a pair of simultaneous integral equations in momentum space. Following Fock, these equations are transformed into ones in a four-dimensional hyperspace and the solutions are obtained in terms of series of O(4) harmonics. As a simple illustration of the method, the Bethe-Salpeter equation for the scalar-meson system is also considered. It is found that the pion-nucleon Bethe-Salpeter equation shows an accidental degeneracy in the discrete-energy spectra similar to that in the solutions of the Dirac equation for the hydrogen atom, provided the coupling constant does not exceed a certain critical limit. The scalar problem exhibits at small binding energies a Schrödinger-type degeneracy. Convergence criteria for the pion-nucleon Bethe-Salpeter eigensolutions as series in O(4) harmonics are discussed; it is found that no solution exists when the coupling constant exceeds a certain critical value. In this approximation scheme, there are no abnormal solutions as are encountered in the fully covariant treatment of the equation. (auth)

10762 HIGH-SPIN BARYONS IN THE CUTKOSKY BOOTSTRAP MODEL. Pellinen, R. (Univ., Helsinki). Nucl. Phys.; B14: 531-42(1969).

The Cutkosky bootstrap equations are investigated for static meson–baryon scattering in the case of degenerate baryon masses are investigated. First P-wave meson–baryon scattering are considered and it is found that the symmetry group $SU(2)_S \otimes O(3)_K$ for the meson–baryon interaction suggested first by Golowich can be replaced by the group $SU(2)_I \otimes SU(2)_J \otimes SU(2)_K$. The quantum number S is identified with isospin I and the so-called K-spin can have both integer and half-integer values. The reduced coupling constants are found to be non-vanishing only if the spin J can be obtained by vectorial addition of I and K as was assumed by Golowich from the beginning. As a consequence of the bootstrap equations it follows that the meson–baryon interaction is invariant under the group $SU(2)_I \otimes SU(2)_J \otimes SU(2)_K \otimes U(1)_Y$. Using this fact, a solution is obtained for the meson-baryon coupling constants for scattering of arbitrary mesons in all partial waves on baryons with arbitrary parity and strangeness. (auth)

10763 ON-MASS-SHELL CURRENT ALGEBRA AND PION–NUCLEON SCATTERING. Carreras, B. (Univ. of Glasgow); De Rujula, A. Nuovo Cim.; 64A: 1014-32(21 Dec 1969).

PCAC, current algebra and a weak form of the isobaric model of the "current-nucleon amplitude" are used to calculate the subtraction functions to fixed-t dispersion relations for the invariant amplitudes describing pion-nucleon scattering, the scattered particles not being taken off their respective mass shells. The expressions so obtained are projected into partial waves and compared with the experimental information in the low-energy region (pion kinetic energy up to 500 MeV). The results are satisfactory. (auth)

10764 THE PSEUDOSCALAR PION–NUCLEON INTERACTION WITH THE METHOD OF UNITARY PADE APPROXIMANTS OF THE S-MATRIX. Mignaco, J. A. (Univ., Geneva); Pusteria, M.; Remiddi, E. Nuovo Cim.; 64A: 733-97(21 Dec 1969).

The formalism for the application of the Padé method to the S-matrix of the pion-nucleon scattering with the pseudoscalar field theory is introduced. The results of the pseudoscalar pion-nucleon theory due to the first nontrivial approximant and without any phenomenological parameter are in satisfactory agreement with the experimental $T = \frac{1}{2}$ phase shifts (S_{31}, P_{31}, D_{35}, D_{33}, and P_{33}, up to roughly 1500 MeV cm total energy), except for the width of the P_{33}, which seems related with more involved dynamics than the one considered here. An interesting consistency between the $\lambda_{\pi\pi\to\pi\pi}$ term in the present problem and the one predicted from the pure boson-boson interaction is achieved. The situation changes in the isospin $T = \frac{1}{2}$ where the mechanism of absorption with coupled channels and more inelastic contributions (by using approximants of higher order and matrices in two-body channel space) seem necessary to reproduce the strongly absorbed phase shifts. (auth)

10765 ON THE MULTIPLICITY DISTRIBUTION OF HIGH-ENERGY PION–NUCLEON AND NUCLEON–NUCLEON INTERACTIONS BEYOND 1 GeV. Bozoki, G. (Central Research Inst. of Physics, Budapest); Gombosi, E.; Posch, M.; Vanicsek, L. Nuovo Cim.; 64A: 881-99(21 Dec 1969).

The experimentally observed multiplicity distributions of charged secondaries in pion-nucleon and nucleon-nucleon interactions at primary energies beyond 1 GeV are analyzed. It is shown that these distributions can be better approximated by a function of the form $f(n) = c^{-1} n^{\beta-1} \exp[-n^2/2\alpha^2]$ than by the Poisson multiplicity distribution of the form $f(n) = c^{-1} \exp[-\lambda] \lambda^n/n!$. The energy dependence of the parameters α, β, and λ, and that of the average multiplicity, the ratio of the average multiplicity to the dispersion and the inelastic cross section for the production of n charged secondaries are all investigated. Rules for the ratio of the inelastic cross section for the production of n charged secondaries in πN interactions to that in NN interactions, as well as for the ratio of the average multiplicity of πN interactions to that of NN interactions are established. (auth)

10766 BOUNDS ON COUPLING CONSTANTS IN EXISTENCE THEOREMS FOR THE LOW EQUATION. McDaniel, H. (Illinois Inst. of Tech., Chicago); Warnock, R. L. Nuovo Cim.; 64A: 905-26(21 Dec 1969).

An earlier existence proof for solutions of the one-meson Low equation is extended and improved. It is shown that the Low equation has an iterative solution, which is analytic in the coupling constant. The Low equation is investigated also in a crossing-symmetric inverse amplitude formulation. The inverse equation has an iterative solution, which leads to a ghost-free solution of the Low equation. The proofs are valid if certain upper bounds on the coupling constant are respected. Numerical values of those bounds (for πN scattering and a particular cut-off function) are given in each of three formulations of the Low equation: the Low equation itself, the inverse amplitude equation, and the N/D equation. The bounds prove to be disappointingly small, whether the existence proofs are done by Schauder's fixed-point theorem or by the iterative method of Banach's fixed-point theorem. It appears that entirely different methods will be needed to investigate solutions with the coupling constant near its physical value. (auth)

10767 ELASTIC πN SCATTERING AND CHARGE EXCHANGE WITH ACCOUNT OF CONTRIBUTION FROM REGGE CUTS. Glebov, V. Yu.; Kaidalov, A. B.; Sukhorukov, S. T.; Ter-Martirosyan, K. A. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz.; 10: 1065-80(Nov 1969). (In Russian).

Experimental data on elastic $\pi^+ p$ scattering and $\pi^- p$ charge exchange are analyzed in framework of complex angular momenta method taking into account the moving branch points. The contribution from the cuts is parametrized in a simple form which corresponds to the optical rescattering model. Reasonable agreement with the experiment in the region of small momentum transfers is obtained. (auth)

10768 FINAL-STATE INTERACTIONS ANALYSIS FOR THE REACTION $\pi^- + p \to \pi^- + K^0 + \Sigma^+$. Chiang, Heng-Ching. Pittsburgh; Carnegie-Mellon Univ. (1968). 127p.

Thesis.

The final state interactions effects in the reactions are examined in two models. It is shown that in the Olsson-Yodh isobar model only small effects in the Dalitz plot will be produced. In Aitchison's rescattering model, with a reasonably assumed π-K interaction strength, appreciable effects in the Dalitz plot can be produced. The general feature of changes are in accordance with Schmid's general argument. The π-K rescattering effects on the polarization of Σ-particle are examined. It is concluded that even if rescattering effects are important, a determination of the parity of the $Y_0^*(1405)$ by measuring the polarization of Σ-particles is still plausible. (Diss. Abstr.)

10769 EXCHANGE DEGENERACY AND THE QUARK MODEL OF HIGH-ENERGY SCATTERING. Fialkowski, K. (Jagellonian Univ., Krakow). Acta Phys. Pol.; 36: 1007-10 (Dec 1969).

Exchange degeneracy for the quark amplitudes is discussed. Implications for physical two-body reactions are investigated. Unified description of all exchange degeneracy predictions is given. (auth)

10770 CORRECTIONS TO THE QUARK MODEL AND EXCHANGE DEGENERACY. Fialkowski, K. (Jagellonian Univ., Krakow). Acta Phys. Pol.; 36: 491-3(Sep 1969).

The experimentally observed small deviations from the exact exchange degeneracy rules for total cross sections are explained in terms of three-quark corrections to the conventional quark model. (auth)

10771 A STRICT PHENOMENOLOGICAL CONNECTION BETWEEN DIPS AND RESONANCES IN PION–NUCLEON SCATTERING. Odorico, R. (Univ., Trieste, Italy. Istituto Nazionale di Fisica Nuclear, Trieste, Italy). Nuovo Cim., Lett.; 2: 655-8 (11 Nov 1969).

It is shown that the more prominent dips and resonances experimentally known in pion–nucleon elastic and charge exchange scattering represented on the plane of s, t, and u variables are strongly and simply interconnected. (J.F.P.)

10772 STATISTICAL DETERMINATION OF INELASTIC COLLISIONS OF FAST PARTICLES WITH INTRANUCLEAR NUCLEONS. Barashenkov, V. S.; Gudima, K. K.; Toneev, V. D. (Joint Inst. for Nuclear Research, Dubna, USSR). Acta Phys. Pol.; 36: 415-32(Sep 1969). (In Russian).

The Monte Carlo method was used to determine the scattering angle and energy for each secondary particle produced in inelastic collisions, which would satisfy the conservation law for energy-momentum and also lead to the assigned distribution. The multiplicity of the secondary particles was also determined. In the case of πN interactions, the multiplicity, which was based on the assumption that the number of π^0 mesons should be one half the number of $\pi^\pm$ mesons produced, was considerably higher than the magnitudes obtained from experiment. An approximation was also found by statistical calculations based on SU(3) symmetry. Angular and momentum distributions were correlated. Polynomial approximations for integral angular and momentum distribution of secondary particles for inelastic and elastic NN and πN interactions were found for $T \lesssim 30$ GeV. The obtained approximations were used for calculating intranuclear cascades. (tr-auth)

10773 CROSS SECTIONS FOR THE MESON–BARYON TWO-BODY REACTIONS AND THE QUARK MODEL. Hofmokl, T. (Inst. of Experimental Physics, Warsaw); Szeptycka, M. Acta Phys. Pol.; 36: 929-38(Dec 1969).

A comparison is presented of the predictions of the quark model with the existing experimental data for the production of pseudoscalar and vector mesons in two-body reactions with charge exchange but no strangeness exchange. (auth)

10774 WAVE FUNCTIONS OF UNSTABLE PARTICLES. Jersak, J. (Univ. of Bern). Czech. J. Phys.; 19: 1523-32 (1969).

The assumptions necessary for the determination of the wave functions of unstable particles are formulated. (auth)

10775 RESONANCES AS UNSTABLE PARTICLES WITH INTERNAL DEGREES OF FREEDOM. Lokajicek, M. V. (Inst. of Physics, Prague). Czech. J. Phys.; 19: 1549-55(1969).

A quantum-mechanical description of unstable particles is given. It is assumed that every unstable particle has a certain number of internal states with nonzero transition probabilities between the states. The mass distribution of such a particle can be different in each decay channel. Resonance curves having two or more peaks can be obtained. (auth)

10776 INFLUENCE OF HELICITY CHANNELS ON THE DISTRIBUTION ASPECT OF SOME QUASI-TWO-BODY TRANSFER INTERACTIONS. Andreescu, Ileana (Univ., Bucharest). Rev. Roum. Phys.; 14: 563-5(1969). (In French).

The effects of helicity channels on the cross sections for the interactions $\pi + N \rightarrow \pi\,(\rho) + \Delta\,(1236)$, and $\pi + N \rightarrow A_2\,(\eta)(\rho) + N$ are analyzed. Curves for the helicity cross sections are shown. (J.F.P.)

Strong (Baryon No. ≥ 2)

Refer also to abstracts 10668, 10772, 10909, and 10917, and 11026.

10777 (SU-1206-211) REGGE-POLE EIKONAL THEORY FOR SMALL-ANGLE NUCLEON–NUCLEON AND ANTINUCLEON–NUCLEON SCATTERING. Blackmon, Maurice L.; Goldstein, Gary R. (Syracuse Univ., N. Y. Dept. of Physics). Oct 1969. 25p. (NYO-3399-211). Dep. CFSTI.

An eikonal model is presented for the small-angle, high-energy scattering of nucleons and antinucleons on nucleon targets. The model uses a flat Pomeranchon with a residue function given by a squared dipole. Also exchange degenerate trajectories and residue functions are used for the three pairs of Regge poles (the ω and P′, the (ρ and A_2, and the π and B). Using previous work to fix trajectories and relative sizes of residue functions, it is found that the model describes elastic processes satisfactorily. Differential cross sections and polarizations are calculated. Also the charge exchange reactions $np \rightarrow pn$ and $\bar{p}p \rightarrow \bar{n}n$ are discussed. (auth)

10778 (SU-1206-216) UNIVERSAL THEORY OF PRIMARY INTERACTIONS, SCALAR MESONS, AND NUCLEON–NUCLEON SCATTERING. Chiang, C. C.; Gleiser, R. J.; Huq, M. (Syracuse Univ., N. Y. Dept. of Physics). Nov 1969. 32p. (NYO-3399-216). Dep. CFSTI.

The nucleon-nucleon phase shifts are calculated by adding the exchange of the scalar isoscalar meson ϵ to previous calculations based on the universal theory of primary interactions proposed previously. Some improvements are obtained. In particular the $1S_0$, $1D_2$ and $3P_2$ results are good for $(g^2_{\epsilon NN}/4\pi \approx 13.5)$ and a hard core cutoff at 0.4F. (auth)

10779 ELASTIC PROTON–DEUTERON SCATTERING AT LARGE ANGLES. Craigie, N. S.; Wilkin, C. (University Coll., London). Nucl. Phys.; B14: 477-88(1969).

The large angle elastic proton–deuteron differential cross section at about 1 GeV is calculated from a triangle graph which includes as input the $pp \rightarrow \pi d$ amplitude. The predicted cross sections are rather low, but the shapes are in good agreement with the experimental data. A maximum in the 180° cross section is predicted for a proton kinetic energy of 700 MeV. (auth)

10780 A BREMSSTRAHLUNG MODEL FOR PROTON–PROTON ELASTIC SCATTERING AT HIGH ENERGIES. Gemmel, H.; Kastrup, H.A. (Univ., Munich). Nucl. Phys.; B14: 566-72(1969).

The elastic proton–proton cross section is calculated in the framework of a bremsstrahlung model. Adjusting only one free parameter good overall agreement is obtained with experiments for lab energies up to at least 20 GeV. (auth)

10781 MULTI-STEP CONTRIBUTIONS TO PARTICLE PRODUCTION IN NUCLEI. von Bochmann, G.; Margolis, B. (McGill Univ., Montreal). Nucl. Phys.; B14: 609-18(1969).

Coherent and incoherent production of particles in atomic nuclei is investigated for high energies using coupled equations of optical model form for the wave functions of the particles. Multi-step (cascade) processes for coherent production and one incoherent step preceded or followed by coherent scattering or production for incoherent production are included. Calculations are performed for a coupled π. A_1. A_3 system. Given the cross sections for the corresponding reactions of pions on nucleons, it is found that for coherent A_3 production the one-step process is likely dominant whereas for A_3 production two-step processes can be of considerable importance. The incoherent production cross section is changed appreciably if two-step processes are included. The unknown coupling of the A_3 to the A_1 as well as the possibility of an appreciable contribution of other intermediate boson states makes the detailed calculation of A_3 production in nuclei difficult. (auth)

10782 ABSORPTIVE CONTRIBUTION TO πD SCATTERING LENGTH. Beder, Douglas (Univ. of British Columbia, Vancouver). Nucl. Phys.; B14: 586-92(1969).

An unsubtracted dispersion representation is used to estimate $\alpha_{\pi D}$ arising from two nucleon intermediate states. Because of the large physical region cross section of $\pi D \rightarrow pp$ (due to the 3-3 resonance) the result, which differs from previous estimates, is $\mathrm{Re}\, a_{abs} = +0.06\,\mu^{-1}$. (auth)

10783 MULTIPLE RESCATTERING IN HIGH ENERGY PARTICLE INTERACTION. Ter-Martirosyan, K. A. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz.; 10: 1047-64(Nov 1969). (In Russian).

The Reggeon graph Gribov's technique is applied to the concrete cases of πN and NN scattering in the region of not superhigh but accessible energies. The general method is illustrated using the example of simplest graphs corresponding to the rescattering without production of showers in the intermediate state, after each next scattering. The sum of contributions from these graphs gives simple formulas of the "optical" or eikonal approximation. On the basis of a special assumption on the Gaussian form of the Regge vertices corresponding to the transition of two particles into several reggeons formulas are obtained more accurate than optical ones but including a number of unknown parameters. For the case of πN and NN scattering these formulas are reduced to a form convenient for comparison with experimental data. All calculations are performed in the energy representation without transition to the complex j-plane. (auth)

10784 THE SIMPLE AND STRICT INTERCONNECTION BETWEEN THE OBSERVED RESONANCES AND DIPS IN pp AND $\bar{p}p$

SCATTERINGS. Odorico, R. (Univ., Trieste, Italy). Lett. Nuovo Cim.; 2: 835-8(11 Dec 1969).

The structures in $p + p \rightarrow p + p$ and $\bar{p} + p \rightarrow \bar{p} + p$ interactions are plotted on the s, t, u plane. These structures are found to be strongly and simply interconnected similar in many ways to $\pi + p$ scattering. The shrinking of pp and antishrinking of $\bar{p}p$ forward peaks, the presence of structure in low-energy $\bar{p}p$ and its absence in low-energy pp, and the discontinuities in the 90° pp differential cross section are explained. (J.F.P.)

10785 DIFFERENTIAL CROSS SECTION FOR ELECTRON–POSITRON PAIR PRODUCTION FROM NEUTRON–PROTON SCATTERING. Wheeler, Robert Dalton. Logan, Utah; Utah State Univ. (1968). 83p.

Thesis.

The differential cross section for a neutron–proton collision forming an electron-positron pair is calculated. The interaction between the neutron and proton is assumed to be pseudoscalar and that between the proton and the pair electromagnetic. The interaction between the pair and the neutron is assumed negligible. The methods used to obtain the matrix elements of the process follow that of Möller. The calculation is therefore based on retarded interaction and is relativistic. In obtaining the square of the matrix elements the initial and final polarization states were not considered. The usual projection operator methods were then applied to the intermediate states which led to traces and trace products. The traces were calculated on an IBM 7090 computer with the readout being of alphabetic form. The output consisted of dot products of four vectors, with the four vectors specifying the energy and momentum of the various particle states. A second computer program was written to determine the momentum and energy distribution among the particle states for a special symmetrical scattering case. The data obtained from this program was used as input for a third computer program which obtained a plot of differential cross section versus incident proton energy, the proton energy running from 960 MeV to 1065 MeV. The results depicted by the graphs are discussed and additional work recommended. (Diss. Abstr.)

10786 ON THE REAL PART OF THE FORWARD PROTON–PROTON SCATTERING AMPLITUDE. Staszel, M. (Warsaw Univ.). Acta Phys. Pol.; 36: 963-70(Dec 1969).

An attempt was made to obtain the ratio of the real to imaginary part of the proton–proton forward scattering amplitude from the experimental values of differential cross section by taking into account the full spin dependence of the nuclear amplitude. On the other hand, the value of Re f/Im f was calculated for the Regge-parametrized p-p amplitude with the contribution of the cut in the complex j-plane. The possible influence of pion conspiracy on the value of Re f/Im f was also checked. (auth)

10787 DISPERSION RELATIONS FOR ELASTIC n–d SCATTERING. Avishai, Y.; Ebenhoeh, W.; Rinat-Reiner, A. S. (Weizmann Inst. of Science, Rehovot, Israel). Ann. Phys. (N.Y); 55: 341-73(Nov 1969).

Partial wave N/D equations for elastic n-d scattering are solved for the $S = \frac{1}{2}, \frac{3}{2}$ channels. Three-particle contributions to unitarity for the decoupled $S = \frac{3}{2}$ channels are approximately incorporated by using final state interactions between pairs in three-particle intermediate states. The equations for pairs of coupled $S = \frac{1}{2}$ channels cannot be solved by standard methods and single channel Frye–Warnock equations with known inelasticities are considered instead. Driving forces are derived from single and double nucleon exchange. The latter are important down to the elastic threshold due to the anomalously long range of the one-nucleon exchange force. Real and imaginary parts of $l = 0, 1, 2$ phase shifts, differential cross sections and the binding energy of the triton are computed and found to be in general agreement with experiment. Threshold behavior of the $S = \frac{1}{2}$, $l = 0$ phase and the position of the triton pole are shown to be sensitive to small changes in the input. The influences of vertex corrections, the virtual two-nucleon state, the break-up inelasticity and off-shell behavior entering in the continuum approximation were investigated in detail. In conclusion the N/D approach is compared with the standard Fadde'ev–Lovelace potential theory. (auth)

10788 EQUIVALENCE OF THE delta' AND THE HARD CORE POTENTIALS. Schenter, R. E.; Zwibel, H. S.; Cassola, R. L. (Battelle-Northwest, Richland, Wash.). Amer. J. Phys.; 37: 1242-5(Dec 1969).

The introduction of the hard-core potential into the two-body problem forces the system wave function to vanish, if the interacting particles approach each other more closely than the hard core radius. It is shown that this "hard core effect" can also be obtained in two-body problem by replacing the hard core potential with a δ' interaction of suitable strength. (auth)

10789 ABSORPTION OF POSITIVE PIONS BY DEUTERON. Lazard, C. (Institut de Physique Nucleaire, Orsay, France); Ballot, J. L.; Becker, F. Nuovo Cim., B; 65: 117-46(11 Jan 1970).

Absorption of positive pions by deuterons is studied in a theory based on a Lagrangian formalism for the πN interaction. Total cross section, angular distribution and polarization are estimated from threshold to 300 MeV pion kinetic energy. Starting from the nonrelativistic limit of the PS(PV) πN interaction the Born term, the forward and backward rescattering pion terms, as well as the nucleon–nucleon rescattering in final state are taken into account. Different wave functions are used for the deuteron and for the two-proton final state which differ only at short distances. Conclusions are drawn about the sensitivity of theoretical results to the behavior of NN wave functions at short distances. The results are compared to experimental data. (auth)

Particle Invariance Principles and Symmetries

10790 SEARCH FOR HEAVY STABLE PARTICLES IN COSMIC RAYS AND MOMENTUM SPECTRUM OF SEA LEVEL COSMIC-RAY MUONS INCIDENT AT 75^0 TO THE ZENITH. Stefanski, Raymond Joseph. New Haven; Yale Univ. (1968). 90p.

Thesis.

The results of two separate measurements made with a large magnetic spectrograph which was designed and built to observe cosmic ray particles are reported. A search was made for heavy stable particles which might be found in cosmic rays and measurements were made of the momentum spectrum of cosmic ray muons observed at sea level. The measurement of the muon momentum spectrum was made for momenta extending up to 300 GeV/c for muons incident at 75° to the zenith. The results are consistent with predictions based on the assumption that cosmic ray muons are the progeny of pi and K-mesons produced in the interactions of the primary cosmic radiation with atmospheric nuclei. For the heavy particle search, the main objective of the experiment was to detect heavy triplets which might form the bases of the SU(3) symmetries observed in elementary particles, but the results also concern particles of other possible origins. Four possible heavy particles were found in 700 hours of running, where estimates indicate that five background events were to be expected for the run. Since the number of heavy particles detected is consistent with background, an upper limit for the flux of heavy particles can be established and this limit is 2.4×10^{-8} $(cm^2 \cdot sr \cdot s)^{-1}$ for particles with velocity between 0.5c and 0.75c. This limit on the observed flux is interpreted, with the aid of plausible assumptions for the character of triplet production and diffusion through the atmosphere, to give an upper limit of about 2 microbarns for the production cross section of triplets of mass less than 15 GeV/c^2. (Diss. Abstr.)

General

10791 C, CP, AND T DISCRETE SYMMETRIES. Jacob, M. (CEN de Saclay, Gif-sur-Yvette, France). pp 123-44 of Colloque National de Physique Theorique. Exposes Generaux sur des Sujets d'Actualite, Marseille, 19–22 Avril 1967. Paris; Centre National de la Recherche Scientifique (1969). (In French).

From National Conference on Theoretical Physics, Marseille, France. See CONF-670459.

The review of C, CP, and T invariance covers invariance and symmetry, invariance and P, C, and T violation, neutral K decay and PC violation, possible violation of charge conjugation invariance, and charge conjugation and time reversal invariance. (J.F.P.)

10792 MATRICES OF FINITE LORENTZ TRANSFORMATIONS IN A NONCOMPACT BASIS. II. CONTINUOUS SERIES OF O(2,1). Mukunda, N. (Tata Inst. of Fundamental Research, Bombay). J. Math. Phys. (N. Y.); 10: 2092-8(Nov 1969).

The representation matrices in a noncompact basis for finite elements of the group O(2, 1) are determined in the continuous classes of unitary irreducible representations. Integral as well as half-integral, and exceptional as well as nonexceptional, representations are treated. (auth)

10793 ON REPRESENTATIONS OF THE INHOMOGENEOUS DE SITTER GROUP AND EQUATIONS IN FIVE-DIMENSIONAL MINKOWSKI SPACE. Fushchich, V. I. (Mathematical Inst., Kiev); Krivskii, I. Yu. Nucl. Phys.; B14: 573-85(1969).

A continuation and elaboration are made of a brief notice where some approach to the variable-mass problem was proposed. Here is found a definite realization of irreducible representations of the

inhomogeneous group P(1,n), the group of translations and rotations in (1 + n)-dimensional Minkowski space, in two classes (when $P_0^2 - P_k^2 > 0$ and $P_0^2 - P_k^2 < 0$). All P(1,n)-invariant equations of the Schrödinger–Foldy type are written down. Some equations of physical interpretation of the quantal scheme based on the inhomogeneous de Sitter group P(1,4) are discussed. The analysis of the Dirac and Kemmer-Duffin type equations in the P(1,4) scheme is carried out. A concrete realization of representations of the algebra P(1,4) connected with this equations, is obtained. The transformations of the Foldy–Wouthuysen type for this equations are found. It is shown that in the P(1,4) scheme of the Kemmer–Duffin type equation describes a fermion multiplet like the nucleon–antinucleon. (auth)

10794 MODEL OF CP VIOLATION. Tomozawa, Y. (Univ. of Michigan, Ann Arbor). Phys. Lett.; 30B: 543-5(8 Dec 1969).

A model of the weak interactions mediated by a nonet or an octet of W-mesons is presented. The model contains the CP violating phase intrinsically. (auth)

10795 WAVEFUNCTIONS ON HOMOGENEOUS SPACES. Bacry, Henri (Centre de Physique Theorique, Marseille); Kihlberg, Arne. J. Math. Phys. (N. Y.); 10: 2132-41(Dec 1970).

The properties of a class of homogeneous spaces of the Poincaré group are discussed. An 8-dimensional space appears especially promising and the explicit unitary irreducible representations corresponding to physical particles are given using scalar wavefunctions on this space. (auth)

10796 THE DYNAMICAL ORIGIN AND THE BREAKING OF THE SU_3 SYMMETRY OF ELEMENTARY PARTICLES. Rittenberg, V. (Inst. of Physics, Bucharest). Stud. Cercet. Fiz.; 21: 603-40(1969). (In Rumanian).

The study of the dynamical origin and breaking of SU(3) symmetry covers irreducible tensors of the SU(3) group, irreducible tensors corresponding to the (0,q) representation, the dynamical origin of internal symmetries including the Cini–Fubini amplitudes for pseudoscalar-meson multiplet-pseudoscalar-meson multiplet scattering, SU(2), SU(3), and G(2) symmetries, and the derivation of SU(3) symmetry without assuming SU(2) symmetry. The discussion also concerns SU(3) breaking in a crossing symmetric bootstrap model including the bootstrap model, application of tensorial methods to solve the bootstrap equations and the theory of octet-enhancement, perturbation theory for the crossing-symmetric bootstrap model, and comparison of the present results with those obtained by other methods and with experimental data. Lastly, the medium-strong interaction mediated by an isotriplet covering SU(3) breaking by a boson isotriplet, pions with spin and the medium-strong interaction, and self-consistent calculation of the vector-meson octet in the presence of a symmetry-breaking isotriplet. (auth)

Applications (Electromagnetic and Weak)

Refer also to abstracts 10659 and 10704.

10797 COMPARISON OF π^+ AND π^- LIFETIMES AS A TEST OF CPT INVARIANCE. Ayres, David Smith. Berkeley, Calif.; Univ. of California (1968). 156p.

Thesis.

One of the consequences of the CPT theorem is the prediction that a particle and its antiparticle will have equal lifetimes. The experiment described tests that prediction by comparing the mean lifetimes of π^+ and its antiparticle π^-. The result of the measurement was $\tau_{\pi^+}/\tau_{\pi^-} = 1.00055 \pm 0.00071$, which is consistent with the prediction of the CPT theorem. The experimental method was to measure the fraction of surviving pions at several positions along a 35-ft (one-half lifetime) decay path. The beam polarity was alternated frequently between positive and negative particles, and many precautions were taken to ensure that the π^+ and π^- beams were identical in their spatial and momentum distributions. Most of the running time was spent investigating possible sources of systematic bias which might make the lifetimes appear to be different, and a number of these systematic errors were found and eliminated. This experiment represents a considerable improvement over an earlier one at the 184-in. cyclotron. The most significant changes were a 100-fold increase in the pion beam intensity, and the use of charge-symmetric liquid deuterium in the focusing Cherenkov counter which detected pions along the decay path. (Diss. Abstr.)

10798 THE κ MESON AS A MEASURE FOR THE SYMMETRY BREAKING IN CURRENT DIVERGENCE COMMUTATION RELATIONS. Schuelke, Lothar (Weizmann Inst. of Science, Rehovoth, Israel). Nucl. Phys.; B14: 619-29(1969).

Commutation relations between charges and current divergences are sandwiched between the vacuum and the spin-zero meson states. Neglecting continuum states in saturating the commutators, and making consistently an unsubtracted pole ansatz for the various matrix elements of divergences of currents according to PCAC (PCVC), the implications of these equations are studied. The following are obtained: a) a set of equations that has already been derived from current algebra, if supplemented by the same additional assumptions; b) an expression for the parameter γ which relates the SU_3–and chiral symmetry breaking part in the Hamiltonian; and c) a sum rule for the weak decay constants of the mesons. The formulas derived from the commutation relations are shown to be valid for arbitrary momenta of the particles. (auth)

10799 VIOLATION OF P-PARITY IN INELASTIC SCATTERING REACTIONS WITH PHOTON EMISSION. Karmanov, V. A.; Lobov, G. A. JETP Lett. (USSR) (Engl. Transl.); 10: 212-14(5 Oct 1969).

Translated from Zh. Eksp. Teor. Fiz. Pis'ma Redaktsiyu; 10: 332-6(5 Oct 1969).

An expression is found for the degree of circular polarization of the photons emitted by excited spin-j_3 nuclei produced by inelastic particle scattering. (J.F.P.)

10800 VERIFICATION OF T INVARIANCE IN LEPTONIC RADIATIVE DECAYS OF K MESONS. Safronov, A. N. (Moscow State Univ.). JETP Lett. (USSR) (Engl. Transl.); 10: 244-7 (20 Oct 1969).

Translated from Zh. Eksp. Teor. Fiz. Pis'ma Redaktsiyu; 10: 385-8(20 Oct 1969).

The possibility of verifying T invariance in the decays $K^0 \to e^\pm + \nu + \pi^\mp + \gamma$, and $K^\pm \to e^\pm + \nu + \pi^0 + \gamma$ is considered. An expression for the T-odd part of the square of the matrix element for meson (K^0) decay is given. (J.F.P.)

Applications (Strong)

Refer also to abstracts 10675 and 10985.

10801 (COO-264-527) PHENOMENOLOGICAL LAGRANGIAN MODEL OF CHIRAL SU(3) x SU(3) FOR MESONS AND BARYONS WITH SYMMETRY BREAKING. Lam, Yuk-Ming P.; Lee, Yee Yen (Chicago Univ., Ill. Enrico Fermi Inst. Chicago Univ., Ill. Dept. of Physics). Oct 1969. Contract AT(11-1)-264. 28p. (EFI-69-94). Dep. CFSTI.

Using the techniques of nonlinear realization of SU(3) × SU(3), a Lagrangian is written for the pseudoscalar nonet and $1/2^+$ baryon octet with a symmetry breaking term transforming like a vector in a $(3,3^*) \oplus (3^*,3)$ representation of SU(3) × SU(3). This Lagrangian yields a mass formula (different from the Gell–Mann–Okubo mass formula) for the pseudoscalar octet, and, if we neglect η–η' mixing, then this formula fits the experimental masses to an accuracy of about 1 MeV. From this Lagrangian, explicit expressions of the axial vector currents in terms of particle fields are obtained. The tree-diagram prescription then yields a modified Goldberger–Treiman relation consistent with experimental measurements. (auth)

10802 (ITF-69-54) GROUP EMBEDDING THEORY AND STRONGLY INTERACTING PARTICLES. Kostyrko, I. I. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1969. 9p. (In Russian). (CONF-690417-21). Dep. CFSTI (U. S. Sales Only).

From 3rd Conference on Axiomatical Field Theory and Theory of Elementary Particles, Kiev, USSR.

Recently, a theory of group embedding was applied in the case of nonrelativistic model of hydrogen atom with a view to the bound state spectrum. The above mentioned scheme of group embedding is applied for strongly interacting particles. There is found a symmetry group and a dynamic group for hadrons, the knowledge of which entirely solves the problem of the hadron mass spectrum. It is clear that the group SU(n) ⊗ SU(n) is a symmetry group for hadrons and the group SU(2n + 1) is a dynamical group. The obtained theoretical results are compared with experimental data. (auth)

10803 (KFKI-22-1969) C VIOLATION IN η DECAY? Frenkel, A.; Vesztergombi, G.; Marx, G. (Magyar Tudomanyos Akademia Konzponti Fizikai Kutato Intezete, Budapest). 1969. 20p. Dep. CFSTI (U. S. Sales Only).

The recent experimental results on the charge asymmetry in η decay were compared with a theoretical model of C violation. Five asymmetry parameters of the $\eta \to \pi^+\pi^0\pi^-$ energy distribution were defined and their measured values reproduced by the model within one standard deviation. The implication of the experimental upper limit on the $\eta \to \pi^0 e^+ e^-$ decay was also taken into account. Order of

magnitude estimates indicate that the model is not in contradiction with the experimental results on the K_L decay. (auth)

10804 DYON THREE-TRIPLET MODEL OF HADRONS. Han, M. Y.; Biedenharn, L. C. (Duke Univ., Durham, N. C.). Phys. Rev. Lett.; 24: 118-21(19 Jan 1970).

Schwinger's composite model of hadrons, based on dyons, is formulated as a dyon three-triplet model with the postulated symmetry group SU(3)[electrical] ⊗ [SU(3) magnetic]. The hadron spectrum is dominated by the superstrong magnetic-charge exchange forces; the first "exotic" states are found to be in the meson channel of the $(2D2\bar{D})$ system. This model possesses the good features of the quark model and explains its paradoxes. (auth)

10805 CHECK OF T INVARIANCE IN 635 MeV PROTON–PROTON ELASTIC SCATTERING. Zul'karneev, R. Ya.; Nadezhdin, V. S.; Satarov, V. I. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 10: 973-5(Nov 1969). (In Russian).

The equality "polarization-asymmetry" following from T invariance of interactions was checked in the experiment on pp scattering at the energy 635 MeV. Within the accuracy of the measurements (2 to 4)% in the investigated angle interval (34 to 117°) c.m.s., there were no effects of the T violation. The T-odd scattering amplitude is estimated. The value for noninvariant phase λ_2 is found to be $\sin \lambda_2 = -0.11 \pm 0.10$. (auth)

Field Theories

General

10806 GENERAL CORRESPONDENCE BETWEEN FIELD THEORIES AND THE THEORIES OF DIRECT INTERPARTICLE ACTION. Narlikar, J. V. (Univ. of Cambridge, Eng.). Proc. Cambridge Phil. Soc.; 64: 1071-9(Oct 1968).

It is well known that classical electrodynamics can be described both as a field theory and as a theory of direct interparticle action. It is shown that, provided certain general conditions are satisfied, fields of arbitrary spin have their counterparts in "direct particle fields." This correspondence between the two formalisms is established in the Riemannian space-time used for general relativity. (auth) (UK)

Quantum Field Theory

Refer also to abstracts 10695 and 10719.

10807 (JINR-E2-4734) n-POINT LORENTZ INVARIANT DISTRIBUTIONS. [PART] I. Gheorghe, C.; Mihul, E. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1969. 14p. Dep. CFSTI (U. S. Sales Only).

The isomorphisms between the Lorentz invariant distribution space on the topological product of n Minkowski spaces and the distribution space on the Lorentz invariant variables are given and the spectral representation of the n-point Lorentz invariant distributions is obtained. (auth)

10808 (LNF-69/33) FIELD-CURRENT IDENTITY AND HADRONIC CONTRIBUTION TO THE MUON G-FACTOR. Note No. 447. Etim, E.; Picchi, P. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). 16 May 1969. 5p. Dep. CFSTI (U. S. Sales Only).

The hadronic contribution to the muon g-factor is calculated according to various mixing schemes using field-current identity techniques. (auth)

10809 (SLAC-Trans-108) NONLOCAL QUANTUM FIELD THEORY, NONLINEAR INTERACTION LAGRANGIANS, AND CONVERGENCE OF THE PERTURBATION THEORY-SERIES. Efimov, G. V. ([Joint Inst. for Nuclear Research, Dubna (USSR)]). Translated by T. Watt for Stanford Linear Accelerator Center, Calif., from report JINR-P2-4546. 17p. Dep. CFSTI.

It is shown within the nonlocal quantum theory of one-component scalar field ϕ, that for an essentially nonlinear interaction Lagrangians $L_1(\phi)$, such that $L_1(\phi) \to 0$ at $\phi \to \pm\infty$, the nonlocal form factor can be chosen so that S-matrix will be finite, unitary and macrocausal in each order of perturbation theory, and the whole perturbation series will converge absolutely in the Euclidean region. (auth)

10810 ON THE SELF-ADJOINTNESS OF QUANTUM FIELDS AND HAMILTONIANS. Reed, Michael Charles. Stanford, Calif.; Stanford Univ. (1969). 112p.

Thesis.

A theory of diagonal sums of self-adjoint operators on infinite tensor product spaces is developed and applied to quantum fields and Hamiltonians. Test function spaces for quantum fields are investigated. As an example of the application of this theory to Hamiltonians we show how to choose a representation of the CCR such that $A = \Sigma_{k=1}^{m}\omega_k(p_k^2 + q_k^2 - \tau_k) + \Sigma_{k,l,m,n=1}^{m} d_{klmn}q_kq_lq_mq_n$ is self-adjoint (the d_{kkkk} are positive but arbitrary, the off-diagonal d_{klmn} must be small). A has point spectrum of multiplicity one as lowest point in its spectrum and this physical vacuum is the limit in the Hilbert space of the cut-off physical vacuums. (Diss. Abstr.)

10811 STUDY OF COMPOSITENESS PROPERTIES. Liossatos, Panagis Sotiriou. Philadelphia; Univ. of Pennsylvania (1968). 153p.

Thesis.

The Z = 0 conditions for composite and dynamical particles are studied in the context of Bronzan's version of the Lee model (LBM), where Z stands for any renormalization constant. The LBM describes a world of three static fermions — N, V, and U — and a relativistic boson, θ, interacting via the Yukawa-type couplings $V \rightleftharpoons N + \theta$ and $U \rightleftharpoons V + \theta$. All the particles are chargeless, spinless, etc. The term "composite particle" is to indicate a bound state with one arbitrary parameter — mass or coupling constant — whereas "dynamical particle" refers to a bound state with no free parameter. (TSS) (Diss. Abstr.)

10812 FOUR-PRONGED π^-p INTERACTIONS AT 10 GeV/c IN AN 81-CM HYDROGEN BUBBLE CHAMBER. Abdrakhmanov, E. O.; Basina, A. N.; Vinitskii, A. Kh.; (and others). Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat.; No. 2, 5-16(Mar-Apr 1969). (In Russian).

After scanning 10,000 photographs from an 81-cm hydrogen bubble chamber, which was irradiated at CERN by a π-beam with a momentum of 10.20 ± 0.68 GeV/c, 883 four-pronged interactions were selected. The methods of separating the events $\pi^- + p \to \pi^- + N + \pi^- + n\pi$ into given reaction channels are described. Distributions according to magnitude and missing mass are presented. From the measurement of the average gap length by the method of multiple cell identification, there were approximately 80% of the positive particle tracks selected in the momentum range from 1 to 2 GeV/c. The angular and momentum characteristics of secondary particles were obtained. The asymmetry coefficients for mesons were found for the different reaction channels. A comparison of proton and neutron momentum spectra was made. Cross sections for meson (ρ) and $\Delta(1236)$ production and their relation to the number of produced particles were obtained. The cross sections for A_2 and g^- resonance production were evaluated. (tr-auth)

10813 GENERAL PROPERTIES OF BETHE–SALPETER NORMS. Leigh, W. J. (Univ. of Lancaster, Eng.). Nucl. Phys.; B14: 630-8(1969).

The well-known indefinite metric properties of the ladder-approximated Bethe–Salpeter equation are established on general grounds in terms of normalization conditions due to Nakanshi and to Allcock. Tight-binding solutions are briefly discussed. (auth)

10814 FEYNMAN RULES FOR THE MASSLESS YANG–MILLS FIELD RENORMALIZABILITY OF THE THEORY OF THE MASSIVE YANG–MILLS FIELD. Fradkin, E. S.; Tyutin, I. V. (Lebedev Physical Inst., Moscow). Phys. Lett.; 30B: 562-3(8 Dec 1969).

A simple method of obtaining the unitary S-matrix in the field theory with subsidiary conditions is suggested. The method is applied to the Yang-Mills fields. (auth)

10815 ASYMPTOTIC BEHAVIOR AND OPERATOR MASS RENORMALIZATION IN THE φ^4 MODEL. Aks, S. Oe.; Carhart, R. A. (Univ. of Illinois, Chicago). Nuovo Cim.; 64A: 798-810 (21 Dec 1969).

As is well known in the theory of nonlinear differential equations, straightforward perturbation theory leads to approximate solutions with the wrong asymptotic behavior. A real scalar field satifying the Klein–Gordon equation with a φ^3 self-current, in both the classical and second-quantized versions. It is considered that the usual, approximate solutions are asymptotically unbounded in both cases. A solution is presented up to a normalization factor for the function or Heisenberg operator φ to first order in the coupling with the correct asymptotic behavior. In the quantum case this forces one to introduce a q-number renormalized mass. The discussion is limited to solutions periodic in a finite box. A discussion of the wave-function renormalization and the limit of infinite box volume is deferred here. The method of approximation used is a generalization of standard techniques in the theory of nonlinear differential equations, and does not require adiabatic switching of the interaction. (auth)

10816 ON PROPERTIES OF THE BREMSSTRAHLUNG IN QUANTUM ELECTRODYNAMICS AT HIGH ENERGIES. Ter-ent'ev, M. V. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz.; 10: 1034-46(Nov 1969). (In Russian).

It is shown that in the quantum electrodynamics at high energies the formula for the accompanying bremsstrahlung may be applied in a rather large region. So, $e_\mu F_\mu = (-pe/pk + p'e/p'k)f$ if the following conditions are fulfilled: $2pk \ll s$; $2p'k \ll s$; $2pk \cdot 2p'k \ll sq_\perp$ where $s = 2pp'$ and $q_\perp$ – the transferred momentum. (auth)

10817 PADE APPROXIMANTS AND THE ANHARMONIC OSCILLATOR. Loeffel, J. J. (Univ., Lausanne, Switzerland); Martin, A.; Simon, B.; Wightman, A. S. Phys. Lett.; 30B: 656-8(22 Dec 1969).

The diagonal Padé approximants of the perturbation series for the eigenvalues of the anharmonic oscillator ($a\ \beta\kappa^4$ perturbation of $p^2 + \kappa^2$) converge to the eigenvalues. (auth)

10818 SPONTANEOUS BREAKDOWN OF CURRENT CONSERVATION IN MASSLESS QUANTUM ELECTRODYNAMICS. Maris, Th. A. J. (Univ. Federal do Rio Grande do Sul, Porto Alegre, Brazil). Lett. Nuovo Cim.; 2: 821-5(11 Dec 1969).

It is shown that the nonconservation of a spontaneously broken symmetry current is not only possible but should usually be expected. It is found that when the symmetry is spontaneously broken, the current conservation will in general be also broken. For the current conservation to survive the spontaneous symmetry breaking a very special condition, expressed by the Goldstone theorem, is necessary. The massless quantum electrodynamics of electrons and muons is considered. (J.F.P.)

10819 A GENERAL CLASS OF CUT-OFF MODEL FIELD THEORIES. Jaffe, Arthur M. (Harvard Univ., Cambridge, Mass.); Lanford III, Oscar E.; Wightman, Arthur S. Commun. Math. Phys.; 15: 47-68(3 Dec 1969).

It is shown that Heisenberg picture fields and their vacuum expectation values exist for a wide class of cut-off interactions among fermions and bosons. (auth)

10820 GARDING DOMAIN FOR QUANTUM FIELDS. Reed, Michael C. (Princeton Univ., N. J.). Commun. Math. Phys.; 14: 336-46(31 Oct 1969).

In all representations of the canonical commutation relations, there is a common, invariant domain of essential self-adjointness for quantum fields and conjugate momenta. (auth)

10821 A REMARK CONCERNING THE CHARGE OPERATOR IN QUANTUM ELECTRODYNAMICS. Reeh, Helmut (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Commun. Math. Phys.; 14: 315-25(31 Oct 1969).

The convergence of the integral over the local charge density toward the global charge is investigated within the framework of quantum electrodynamics. (auth)

10822 IMPLEMENTABILITY OF AUTOMORPHISM GROUPS. Borchers, H. J. (Univ., Goettingen, Ger.). Commun. Math. Phys.; 14: 305-14(31 Oct 1969).

Let $\mathcal{A}$ be a C*-algebra and G be a locally compact group acting as strongly continuous automorphisms on $\mathcal{A}$. Let π be a representation of $\mathcal{A}$ then π is a covariant representation if there exists a strongly continuous unitary representation of the group acting on $\mathcal{H}_\pi$ which implements the automorphisms. Necessary and sufficient conditions on a representation π of $\mathcal{A}$ such that π is subrepresentation of a covariant representation and π is subrepresentation of a covariant representation quasi-equivalent to π are given. (auth)

10823 ASYMPTOTIC VALUE OF THE VERTEX FUNCTION IN THE $\alpha(\alpha L)^n$ APPROXIMATION. Truten, V. I.; Fomin, P. I. (Physical-Technical Inst., Kharkov). Zh. Eksp. Teor. Fiz.; 57: 2198-2208(Dec 1969). (In Russian).

The asymptotic value of the renormalized vertex function $\Gamma_\lambda(p, q)$ in the region $p^2 \gg q^2 \sim m^2$ is found with an accuracy to terms linear with respect to m/p and q/p in the so-called $\alpha(\alpha L)^n$-approximation. (auth)

10824 SPECTRAL REPRESENTATIONS IN RENORMALIZABLE THEORY OF A MASSIVE VECTOR FIELD. Medvedev, B. V.; Pavlov, V. P.; Sukhanov, A. D. (Mathematics Inst., Moscow). Zh. Eksp. Teor. Fiz.; 57: 1998-2009(Dec 1969). (In Russian).

Spectral representations for commutators and Green-like functions of the vector currents and fields in the case of renormalizable theories are set up within the framework of the dispersion approach. The contribution of single-particle intermediate states to the spectral density is consistently taken into account. The mass and wave function renormalization constants are expressed in terms of the spectral integrals. Canonical commutators of the Heisenberg fields are set up and the asymptotic condition for the quantization scheme with an additional condition imposed is derived. (auth)

10825 COVARIANT STRUCTURE OF THE TWO-POINT FUNCTION. Oksak, A. I. (Joint Inst. for Nuclear Research, Dubna, USSR); Todorov, I. T. Commun. Math. Phys.; 14: 271-304(31 Oct 1969).

The spectral representation of the two-point function for arbitrary fields proposed recently is rigorously proved and analyzed. The problem is treated in momentum space where the covariant structure is simpler because of the spectrum conditions. For finite-component fields the explicit "matrix" structure is found in coordinate space too and is applied to the definition of time-ordered Green functions for arbitrary spin. The decomposition of the two-point function into kernels of definite spin is carried out in the general case, a necessary and sufficient condition for the growth of the coefficients in this decomposition being given. The positive-definiteness condition (in the case of Hermitian conjugate fields) is fulfilled automatically by the elementary kernels. The formalism of homogeneous distributions in two dimensional complex domain is used throughout. (auth)

10826 REPLY TO VALIDITY OF THE SACHS–SCHWEBEL THEORY OF QUANTUM ELECTRODYNAMICS BY B. FRANK. Sachs, M. (Cambridge Univ., Eng.). Nuovo Cim., Lett.; 2: 652-4(11 Nov 1969).

An error is pointed out in a previous argument that a lack of internal consistency exists in a nonlinear formulation of quantum electrodynamics by Sachs and Schwebel. (J.F.P.)

10827 REGULARIZATION OF ULTRAVIOLET DIVERGENCES IN QUANTUM FIELD THEORY. Montaldi, E. (Univ., Milan, Istituto Nazionale di Fisica Nucleare, Milan). Nuovo Cim., Lett.; 2: 647-51(11 Nov 1969).

A previously given sample rule for the regularization of a distribution product of causal propagators is discussed with restriction to the case of the formal convolution integral. It is shown that the subtraction procedure becomes straightforward if a convenient parametrization is used together with a given identity. (J.F.P.)

10828 LOCAL QUANTUM FIELD THEORY WITHOUT DIVERGENCES. II. Rayski, J. (Jagellonian Univ., Krakow). Acta Phys. Pol.; 36: 995-1005(Dec 1969).

A field formalism with strongly nonlinear, bounded Lagrangians representing infinite sets of many-body interactions, is discussed. Such field theory is free of the usual convergence difficulties. The problem of S-matrix is discussed in connection with a theorem of Haag. It is pointed out that this type of formalism may prove useful in the formulation of a dynamical theory of quarks. (auth)

10829 COMMENTS ABOUT RECENT LETTERS ON SPACE-LIKE STATES. Baldo, M. (Istituto Nazionale di Fisica Nucleare, Catania, Italy); Recami, E. Nuovo Cim., Lett.; 2: 643-6(11 Nov 1969).

A discussion is given on the localization of tachyons and a physical interpretation of spacelike solutions of infinite multiplet wave equations with tachyons. (J.F.P.)

10830 ANALYTIC REGULARIZATION OF SERIES WITH DIVERGENT TERMS. Giambiagi, J. J.; Tiomno, J. (International Atomic Energy Agency, Trieste, Italy). Nuovo Cim., Lett.; 2: 674-8(11 Nov 1969).

General rules for evaluating Fourier transform of Lagrangians expressed as rational functions of field variables are discussed. (J.F.P.)

10831 CERTAIN PROCESSES OF QUANTUM ELECTRODYNAMICS AT HIGH ENERGIES AND SMALL SCATTERING ANGLES. Lipatov, L. N.; Frolov, G. V. (Ioffe Inst. of Physics and Tech., Leningrad). JETP Lett. (USSR) (Engl. Transl.); 10: 254-7(20 Oct 1969).

Translated from Zh. Eksp. Teor. Fiz. Pis'ma Redaktsiyu; 10: 399-402(20 Oct 1969).

Results of calculations of the Feynman diagrams for $\gamma + e$ and $\gamma + \gamma$ scattering are presented. An expression for the amplitude is given, and cross sections for electron pair production are given. (J.F.P.)

10832 FUNCTIONAL INTEGRATION AND THE GENERALIZED MATTHEWS–SALAM EQUATIONS. Zimmerman, Robert L. (Univ. of Oregon, Eugene). J. Math. Phys. (N. Y.); 10: 2169-78(Dec 1970).

Various properties of Feynman functional integrals that appear in quantum field theory are studied. An indefinite functional integral is constructed. For the indefinite functional integral a relation is proven which is analogous in ordinary Riemann in-

tegrals to integration by parts. A special case of this relation gives an integration-by-parts formula for the Feynman functional integrals. In addition, various relations for integrating over variationals and variational derivatives are obtained. Application of these relations gives, among other things, a set of generalized Matthews-Salam equations. (auth)

10833 INFINITE RENORMALIZATION OF THE HAMILTONIAN IS NECESSARY. Glimm, James (New York Univ., N. Y.); Jaffe, Arthur. J. Math. Phys. (N. Y.); 10: 2213-14 (Dec 1969).

It is shown that the unrenormalized Hamiltonian in quantum field theory is unbounded from below whenever lowest-order perturbation theory indicates that this is true. It is concluded that perturbation theory is an accurate guide to the divergence of the vacuum energy in quantum field theory. (auth)

10834 TACHYON LORENTZ TRANSFORMATION. Mariwalla, K. H. (MATSCIENCE, Madras). Amer. J. Phys.; 37: 1281(Dec 1969).

A determination is made as to whether there is anything inconsistent in the equations characterizing tachyon energy and momentum. It is shown that these equations lead to a parametrization of Lorentz transformations that is different from previous transformations, although the equations are not inconsistent. It is shown that both parametrizations are required for a complete understanding of tachyons. (J.F.P.)

10835 VALIDITY OF LORENTZ INVARIANCE AT EXTREMELY HIGH ENERGIES. Subramanian, A.; Vatcha, R. H. (Tata Inst. of Fundamental Research, Bombay). Proc. Indian Acad. Sci., Sect. A; 70: 114-19(Sep 1969).

Experimental data on the distribution of times of arrival of electrons (and muons) in extensive air showers produced by cosmic rays in the energy range 10^{12} to 10^{19} eV were examined to see if there is any evidence for a departure of the velocity of ultra-high energy particles from that of light as suggested by the model proposed by Pavlopoulos. No evidence for such a departure was found. An upper limit to the "fundamental length" occurring in the theory is obtained as $\sim 10^{-21}$ cm. (auth)

Gravitation and General Relativity

Refer also to abstract 10751.

10836 EINSTEIN'S EQUATIONS OF GENERAL RELATIVITY FOR SPHERICAL SYMMETRY AND THE MASS-FUNCTION. Cahill, Michael Edward. Urbana, Ill.; Univ. of Illinois (1969). 98p.

Thesis.

Einstein's theory of general relativity is used to investigate spherically symmetric distributions of material. In an arbitrary orthogonal coordinate system (x^1,θ,ϕ,x^4), for any such distribution of material a function $m(x^1,x^4)$, is found which represents the total quantity of mass-energy entrapped between the center of the material and the two-space of symmetry passing through the point (x^1,θ,ϕ,x^4). This function is a scalar invariant because $2m/r = R^3_{232}$ and both r and R^3_{232} do not change under coordinate transformations involving only x^1 and x^4. The mass function is an integral of two combinations of Einstein's equations, a fact which may be demonstrated by the application of the Bianchi identity to R^3_{232}. A vector J^α may be constructed from the derivatives of m which represents the flow of mass-energy. This vector is orthogonal to the gradient of m and has zero divergence. Thus, for spherical symmetry the mass-energy may redistribute itself but is neither created nor destroyed. (TSS) (Diss. Abstr.)

10837 GENERAL COSMOLOGICAL SOLUTION OF THE GRAVITATIONAL EQUATIONS WITH A SINGULARITY IN TIME. Khalatnikov, I. M.; Lifshitz, E. M. (Inst. for Physical Problems, Moscow). Phys. Rev. Lett.; 24: 76-9(12 Jan 1970).

A way is indicated to construct a general solution of the Einstein equations with a singularity, starting from a previously known solution of a lesser degree of generality. A qualitative description is given of the evolution of the metric in this general solution towards the singularity, which is of a complex, oscillatory nature. (auth)

10838 PROBLEM OF POSSIBLE NONCONSERVATION OF THE BARYON NUMBER IN GENERAL RELATIVITY. Naida, O. N. Yadern. Fiz.; 10: 999-1002(Nov 1969). (In Russian).

Assuming that the violation of the equivalence principle in the general relativity due to finite dimensions of atomic nuclei results in nonconservation of the baryon number, one is able to get estimates of the velocities of the corresponding reactions. These estimates are shown to be in agreement with those obtained from the uncertainty condition for the energy. (auth)

10839 GLOBAL ASPECTS OF THE CAUCHY PROBLEM IN GENERAL RELATIVITY. Choquet-Bruhat, Yvonne (Faculte des Sciences, Paris); Geroch, Robert. Commun. Math. Phys.; 14: 329-35(31 Oct 1969).

It is shown that, given any set of initial data for Einstein's equations which satisfy the constraint conditions, there exists a development of that data which is maximal in the sense that it is an extension of every other development. These maximal developments form a well-defined class of solutions of Einstein's equations. Any solution of Einstein's equations which has a Cauchy surface may be embedded in exactly one such maximal development. (auth)

10840 CONTRIBUTION TO THE THEORY OF THE GRAVITATIONAL FIELD. Polievktov-Nikoladze, N. M. (Tbilisi State Univ., USSR). Zh. Eksp. Teor. Fiz.; 57: 2010-20(Dec 1969). (In Russian).

Possible general relativity equations of gravitation consistent with the empirical data are discussed. It is demonstrated that the equations should apparently contain covariant derivatives of the curvature tensor. It is shown that scalar gravitational waves should evidently exist in nature and the mass of matter should differ from its active gravitational mass (for the sum a mass difference of about 50% may be possible). The explicit form of some probable equations of gravitation for a broad class of gravitational fields is presented and the region of their applicability is indicated. (auth)

10841 GENERAL SOLUTION OF THE GRAVITATIONAL EQUATIONS WITH A PHYSICAL SINGULARITY. Belinskii, V. A.; Khalatnikov, I. M. (Inst. of Theoretical Physics, Moscow). Zh. Eksp. Teor. Fiz.; 57: 2163-75(Dec 1969). (In Russian).

An attempt is made to set up a general solution of the Einstein equations with a physical singularity with respect to time. The general solution possesses the same type of behavior in time as in the case of a metric with a three-parameter motion group of the ninth Bianki type. (auth)

10842 THE COVARIANT FORMULATION OF THE DIFFERENTIAL CONSERVATION LAWS IN GEOMETRIZED THEORY. Folomeshkin, V. N. (Inst. of High Energy Physics, Serpukhov, USSR). Acta Phys. Pol.; 36: 439-49(Sep 1969).

The general-covariant generalization of the standard canonical formalism was formulated. The covariant generalization of the differential "conservation" for the total canonical energy-momentum tensor of a matter gravitational field system was obtained. The expression for the canonical energy-momentum tensor of matter in an arbitrary curved Riemannian space-time was obtained. In total analogy with the standard canonical procedure for a matter field it was shown that it was possible to obtain a correct and theoretically confident expression for the canonical energy momentum tensor of a gravitational field. The total energy-momentum of any system has a single covariant value equal to zero. The energy of free gravitational waves is also identically equal to zero. (auth)

10843 SOLUTION OF THE SPHERICALLY SYMMETRIC PROBLEM IN THE TWO-TEMPORAL THEORY OF RELATIVITY AND OF GRAVITATION. Kalitsin, Nikola; Denev, Iordan. Izv. Fiz. Inst. Aneb, Bulg. Akad. Nauk.; 19: 95-108(1969).

The spherically symmetric problem is solved, and it is concluded that a test body situated at a great distance from the central body will fall in a finite time measured by a far-away observer to the Schwarzschild sphere and for definite time, also measured by a far away observer, will approach the vicinity of the point r = 0. The same conclusion holds for the radial motion of light rays. (J.F.P.)

10844 EFFECT OF GRAVITATION ON THE LORENTZ TRANSFORMATION. Karlov, L. (Univ. of Sydney). Amer. J. Phys.; 37: 1283-4(Dec 1969).

A demonstration is given of the nonlinearities on a standard Lorentz transformation from the imposition of a gravitational field. Restriction is made to the case where the field is parallel to the direction of the relation motion of the two frames. (J.F.P.)

10845 CLASSIFICATION OF ELECTROMAGNETIC AND GRAVITATIONAL FIELDS. Ludwig, Garry (Univ. of Alberta, Edmonton). Amer. J. Phys.; 37: 1225-38(Dec 1969).

The connection between the three main methods of obtaining the Petrov classification is examined. Spinor techniques are used extensively. A five-dimensional complex linear space is introduced whose elements are Weyl tensors. It is found that not only Weyl tensors of type N and type III, but also some Weyl tensors of type I are null vectors in this space. In analogy with the electromagnetic case it is expected that these null vectors correspond to "pure" gravitational radiation. (auth)

10846 CONSERVATION LAWS IN THE GENERAL THEORY OF RELATIVITY. III. SYMMETRY PROPERTIES NOT DESCRIBABLE BY CO-ORDINATE MAPPINGS. Davis, W. R. (North Carolina State Univ., Raleigh); Moss, M. K.; York, J. W. Jr. Nuovo Cim., B; 65: 19-32(11 Jan 1970).

Investigation of the relation between conservation laws in general relativity and certain types of "generalized symmetry properties" (generated by transformations which map space-times onto other space-times which are not describable as co-ordinate mappings) yields, in contrast to the case for coordinate mappings, a very restricted class of possible formal conservation expressions. In particular the affine, projective, and conformal correspondence of Riemannian space-times are considered. Particle and field conservation-law generators are formulated as well as the conditions necessary for conservation laws and related symmetry properties to be admitted. The particle case is illustrated by a well-known quadratic first integral of the geodesic equations of the Friedmann–Lemaitre cosmological space-time which follows in consequence of a projective symmetry property (geodesic correspondence). The field case is illustrated by formulating a conservation law following in consequence of a conformal symmetry property manifested by the familiar plane gravitational wave solutions which are included previously. (auth)

10847 PHILOSOPHY OF A SPACE GENERALIZATION AND THE PROBLEM OF SPINORS IN GENERAL RELATIVITY. Smrz, P. (Univ. of Alberta, Edmonton). Nuovo Cim., B; 65: 147-57(11 Jan 1970).

Without using any particular geometry of the generalized space the idea of considering the space-time coordinates as parameters describing rotations in a complex four-dimensional space is discussed. The transformation properties of the generalized space vector are identical with those of the spinors and from this fact some conclusions of a rather speculative character are drawn. In particular, the mass term in the Dirac equation could describe interaction with empty space in a similar fashion as the charge term describes interaction with electromagnetic field. (auth)

Scattering Theory

Refer also to abstracts 10727, 10814, and 10828.

10848 (COO-264-528) SATELLITE TERMS IN DUAL RESONANCE MODELS. Frampton, P. H.; Rivers, R. J. (Chicago Univ., Ill. Enrico Fermi Inst.). Dec 1969. Contract AT(11-1)-264. 31p. (EFI-69-99). Dep. CFSTI.

It is shown that concomitant with the addition of any satellite term to the beta function ansatz for the four-point function is a significant charge in the level structure. The degeneracy of the level corresponding to spin n on the leading Regge trajectory changes its asymptotic behavior for $n \to \infty$ from the form exp $(a\sqrt{n})$ to the form exp (bn) where a and b are constants. This result is obtained from considerations of the factorization properties of the corresponding N-particle amplitudes. On the basis of this result one must consider reversion to the original Veneziano model with a single term which, however, is known to be rather rigid and inflexible as a one-parameter formula for the relativistic scattering amplitude. (auth)

10849 (ITF-69-39) DISPERSION RELATION AS INTEGRAL EQUATION CONCERNING INELASTICITY COEFFICIENT. IMPOSSIBILITY OF CASTILLIEJO–DALITZ–DYSON CUTS. Chermalykh, G. N. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1969. 27p. (CONF-690417-22). Dep. CFSTI (U. S. Sales Only).

From 3rd Conference on Axiomatical Field Theory and Theory of Elementary Particles, Kiev, USSR.

The partial-wave dispersion relation (p.w.d.r.) is considered as a singular integral equation concerning the inelasticity coefficient $\eta(\nu)$ with the given real part of the phase shift Re $\delta(\nu)$ and the imaginary part of the partial-wave amplitude on the left-hand cut. It is shown that the $\eta(\nu) \to 1$, $\nu \to \nu_1, \infty$ ν_1 is the inelastic threshold, in Banach space. In the solution for η as in the N/D—solution of p.w.d.r. the CDD ambiguity arises, however in form of an arbitrary polynomial in the solution. It is shown also that the discontinuities in Re $\delta(\nu)$ by $\pm\,\tau/2$, resulting in the so-called the CDD cuts, are inconsistent with p.w.d.r. The discontinuities by $\pm\pi$ leading to zeros and CDD poles of the D—function in the N/D equations, however, are allowed and change the solution for the η, in particular the arbitrary polynomial power in the solutions or the additional conditions of the solution existence. (auth)

10850 (ITF-69-65) JOST FUNCTION FOR THE TWO CHANNEL SCATTERING PROBLEM. Kharakhan, M. L.; Shirokov, Yu. M. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1969. 10p. (In Russian). (CONF-690417-20). Dep. CFSTI (U. S. Sales Only).

From 3rd Conference on Axiomatical Field Theory and Theory of Elementary Particles, Kiev, USSR.

The generalization of the Jost function is introduced for the case of the two-channel scattering of nonrelativistic spinless particles under the arbitrary (not necessary local) interaction Hamiltonian. The problem of deriving the two-channel Jost matrix in terms of the physical S-matrix is reduced to the non-singular integral equation for a single function. It is demonstrated that the explicit form for the Jost matrix is obtainable if the usual assumptions hold about the analytical properties of the S-matrix elements. (auth)

10851 S MATRICES. Iagolnitzer, D. (CEN de Saclay, Gif-sur-Yvette, France). pp 41-69 of Colloque National de Physique Theorique. Exposes Generaux sur des Sujets d'Actualite, Marseille, 19–22 Avril 1967. Paris; Centre National de la Recherche Scientifique (1969). (In French).

From National Conference on Theoretical Physics, Marseille, France. See CONF-670459.

An S-matrix formalism is introduced for the calculation of transition probabilities, and some properties of the S-matrix are indicated, with an attempt to prove each step by independent arguments of general field theory or other underlying theory. It is shown how the S-matrix formalism, with certain properties, can effectively lead to the classical description of interaction space–time. Various assumptions of analyticity are then indicated, which are necessary to account for the dynamical aspects of the process. Their compatibility with the hypothesis of S-matrix unitarity, their relation with various physical properties and their internal coherence are studied. Then the principles of maximal analyticity are stated, which are necessary to give complete knowledge of the S-matrix. (tr-auth)

10852 UNITARITY UPPER BOUND ON THE ABSORPTIVE PARTS OF ELASTIC-SCATTERING AMPLITUDES. Singh, Virendra; Roy, S. M. (Tata Inst. of Fundamental Research, Bombay). Phys. Rev. Lett.; 24: 28-33(5 Jan 1970).

A unitarity upper bound on the absorptive part A(s,t) of the elastic-scattering amplitude in the physical region is derived. In the diffraction peak region the bound on A(s,t)/A(s,0) is a function only of the parameter $\sigma_{tot}^2(-t)/4\pi\sigma_{el}$. Assuming the diffraction scattering to be purely absorptive and spin independent the pp, $\bar{p}p$, and $\pi^{\pm}p$ data are found to lie a little below the theoretical upper bound. Further the experimental curve of X(t)/X(0) vs $-4tX(0)/\sigma_{el}$, where $X(t) \equiv d\sigma/dt$, seems "universal." (auth)

10853 ON ANALYTIC EXTRAPOLATION OF FORM FACTORS AND SCATTERING AMPLITUDES. III. EXTRAPOLATION OFF A PART OF THE BOUNDARY. Presnajder, P.; Pisut, J. (Comenius Univ., Bratislava). Nucl. Phys.; B14: 489-99(1969).

A method for extrapolation of scattering amplitudes and form factors from values on only a part of the boundary of their analyticity region is proposed. Apart from extrapolation to points inside the analyticity region an extrapolation to points on that part of the boundary where data are not available is briefly considered. The former problem is related to the determination of coupling constants (pole residues) from data about the amplitude in only a finite low-energy region while the latter enables one to relate values of the amplitude in one energy region to values in another. The method is based on particular sequences of functions, analytic in the analyticity region of the amplitude and "focused" onto a pre-chosen region. It is adapted to actual extrapolations of inaccurate data and attention is paid to related stability questions.(auth)

10854 UNITARY NON-SHRINKING DIFFRACTION PEAKS. Ball, J. S. (Univ. of Utah, Salt Lake City); Zachariasen, F. Contract AT(11-1)-68. Phys. Lett.; 30B: 558-61(8 Dec 1969).

A simplified model of n-particle production amplitudes is constructed, which, combined with unitarity, yields a nonshrinking elastic scattering amplitude, and an integral equation which can be used to determine the shape of the diffraction peak. (auth)

10855 POTENTIAL SCATTERING IN THE LIMIT OF LARGE COUPLING. Chadan, K.; Mourre, E. (CNRS, Marseille). Nuovo Cim.; 64A: 961-78(21 Dec 1969).

A new method is presented for the study of analytic properties of various quantities of interest occurring in potential scattering, such as the wave functions and the Jost functions. The method is based on a transformation of the Green's function of the reduced radial Schrödinger equation, and on some special properties of the Hankel functions, namely the location of their zeros and the behavior of their moduli. Although the method seems to be adapted for studying other analytic properties, the main concern here are analytic and asymptotic properties with respect to the coupling constant g. (L.B.S.)

10856 THEORY OF MANY-PARTICLE SCATTERING. Komarov, V. V.; Popova, A. M. (Inst. of Nuclear Physics, Moscow). Yadern. Fiz.; 10: 1089-1103(Nov 1969). (In Russian).

An operator formalism to deduce the Fredholm-type integral equations for the N-particle scattering amplitudes is presented. The formalism corresponds to the method of summation of nonrelativistic perturbative graphs introduced earlier. The deduction of the equations for the four-particle scattering amplitudes is given. These equations coincide with those obtained recently summing the graphs. Integral equations for the four-body problem, obtained by various methods, are compared. (auth)

10857 DUAL RESONANCE MODEL WITH TWO FERMIONS. Montvay, I. (Eoetvoes Lorand Univ., Budapest). Phys. Lett.; 30B: 653-5(22 Dec 1969).

Multiparticle Veneziano amplitudes with two fermions are constructed. Factorization holds along the leading trajectory without parity doubling. (auth)

10858 THE INCLUSION OF FERMIONS IN DUAL N-POINT FUNCTIONS. Green, M. B.; Heimann, R. L. (Cambridge Univ., Eng.). Phys. Lett.; 30B: 642-5(22 Dec 1969).

Dual amplitudes of the five-point function for two fermions and three scalar bosons are constructed, and are used to obtain a consistent procedure for inclusing two fermions in the general N-point function. (auth)

10859 GROUP-THEORETICAL TECHNIQUES FOR THE CONSTRUCTION OF REGGE AND MULTI-REGGE MODELS. Toller, M. (CERN, Geneva). Riv. Nuovo Cim.; 1: 403-37 (Jul-Sep 1969).

The review of Regge and multi-Regge model construction covers various formalisms and results, the scattering amplitude, group-theoretical variables, the multi-Regge model, analyticity conditions, a Lorentz-pole model, vertex conditions, application to a two-body unequal-mass reaction, and application to phenomenology. (J.F.P.)

10860 ANALYTIC PROPERTIES OF A CLASS OF NON-LOCAL INTERACTIONS. II. Gutkowski, D.; Scalia, A. (Univ., Catania, Italy. INFN, Catania, Italy). J. Math. Phys. (N. Y.); 10: 2306-18(Dec 1970).

A definition is given for the function $S_l(k)$ in the complex l plane for a class of nonlocal interactions, called F, which has been considered previously. The definition is obtained by means of a new class of nonlocal interactions, called G, for which the definition of $S_l(k)$ in the l plane can be determined by a "dynamical interpolation." The analytic properties of potentials of class G are studied. Then a suitable approximation is defined which allows one to approximate any potential of class F by means of potentials of class G. Comparing the analytic properties of potentials of class G which sufficiently approximate any given potential of class F, it is shown that their total scattering amplitudes can be made as near to each other as is desirable and that there exist Regge trajectories which can be made as near to each other as is desirable. With the given definition, $S_l(k)$ turns out to be an analytic function in the complex l plane, but for a finite number of poles. Some general properties of the Regge trajectories are discussed and some examples are given. (auth)

10861 FEYNMAN PATH INTEGRALS AND SCATTERING THEORY. Gelman, Donald; Spruch, Larry (New York Univ., N. Y.). J. Math. Phys. (N. Y.); 10: 2240-54(Dec 1970).

The Feynman path-integral formulation of nonrelativistic quantum mechanics is applied to scattering theory. A particularly appealing result of Feynman's is a variational upper bound (VUB) on the ground-state energy, with the bound expressed in terms of path integrals containing a trial functional $\tilde{S}$. When $\tilde{S}$ is of the standard form $-\int \{(KE) + \tilde{V}\}\, dt/\hbar$, with KE the kinetic energy and $\tilde{V}$ a trial potential, the bound reduces to the Rayleigh–Ritz result. Since $\tilde{S}$ need not be of that form, Feynman's result has interesting new possibilities. For central potentials, Feynman's analysis is extended to the subspace $H^{(L)}$ of states of a given angular momentum L, obtaining a VUB on the energy of the lowest-energy bound state within $H^{(L)}$. By exploiting the analogy between the lowest-energy bound state and the zero-energy scattering state in the no-bound state case, one obtains a VUB on A_L, the parameter which characterizes low-energy scattering in $H^{(L)}$. The bound on A_L is expressed in terms of modified path integrals containing a trial functional $\tilde{S}_L$, and it reduces to the usual result if and only if $\tilde{S}_L$ is of the standard form $-\int \{(KE)_L + \tilde{V}\}\, dt/\hbar$, where $(KE)_L$ is the kinetic energy corresponding to motion with fixed angular momentum $\{L(L+1)\hbar^2\}^{1/2}$. The bound therefore contains new features. Finally, a similar but much simpler bound on A^L is derived by using the regularization $\mathrm{Tr}\,(e^{-\beta H_L} - e^{-\beta H_L^0})$ of the divergent function $\mathrm{Tr}\, e^{-\beta H_L}$, with Tr the trace, H_L^0 the (reduced) free-particle Hamiltonian in $\mathcal{H}^{(L)}$, and $H_L = H_L^0 + V$. (auth)

10862 ON THE UNIQUENESS OF THE SOLUTIONS FOR THE PARTIAL AMPLITUDES IN THE RELATIVISTIC PROBLEM FOR THREE PARTICLES. Stoyanov, D. Izv. Fiz. Inst. Aneb, Bulg. Akad. Nauk.; 19: 167-71(1969). (In Bulgarian).

The uniqueness of the solutions of the system of equations for the "partial" amplitudes in the three-particle problem is proved. The equations for these amplitudes and the amplitudes themselves for the relativistic case were introduced. (auth)

10863 PHYSICAL REGIONS OF SIX-PARTICLE PROCESSES. McNeil, Richard P.; Morrow, Richard A. (Dartmouth Coll., Hanover, N. H.). J. Math. Phys. (N. Y.); 10: 2185-90(Dec 1970).

The physical regions of six-particle processes are constructed in all planes of pairs of Lorentz-invariant variables. As a matter of course, the permissible ranges of the eight independent variables are established. Thus, one application is the determination of the integration limits in phase-space integrals that occur in calculations involving two-to-four and one-to-five particle processes. (auth)

Particle Accelerators

Refer also to abstracts 9634, 9705, 9709, 9717, and 10725.

10864 (AD-694942) NRL VAN DE GRAAFF OPERATION, JANUARY 1–JUNE 30, 1969. Dunning, K. L. (Naval Research Lab., Washington, D. C.). Sep 1969. 39p. (NRL-MR-2038). CFSTI.

A summary of the operation and use of the NRL 5-MV Van de Graaff accelerator and associated instruments for the period of 1 January to 30 June 1969 is given. Brief accounts of the research and development projects under way are included. (auth) (USGRDR)

10865 (AD-694956) REPORT OF LINAC OPERATION, JANUARY 1–JUNE 30, 1969. Interim Report No. 8. Godlove, T. F. (Naval Research Lab., Washington, D. C.). Jul 1969. 29p. (NRL-MR-2031). CFSTI.

The operation and use of the NRL 60 MeV Electron Linear Accelerator is described for the period 1 January–30 June 1969. Progress on the Linac Branch research program is discussed, including results from 180 degree electron scattering on He-3 and He-4, installation of an improved bremsstrahlung converter for photonuclear experiments, and studies of resonance neutron capture. Various linac engineering improvements are discussed. (auth) (USGRDR)

10866 (CISE-N-130) PROJECT OF A 8-MeV TANDEM VAN DE GRAAFF. PART I. THE ELECTROSTATIC GENERATOR. Caruso, E.; Milazzo, M. (Centro Informazioni Studi Esperienze, Milan (Italy)). Oct 1969. 49p. Dep. CFSTI (U. S. Sales Only).

The design of a voltage generator for a tandem Van de Graaff accelerator for accelerating protons and deuterons at 1 to 10 MeV is discussed. Topics include pressure vessel, the stacks of equipotential plates, high voltage electrode, the insulators, short-circuit bar and capacitive pick-up, electrical charging, instrumentation of the electrostatic generator, generator voltmeter, gas handling, and preliminary results. (W.H.K.)

10867 (ITEF-673) A LINEAR ION ACCELERATOR WITH SPATIAL-HOMOGENEOUS STRONG FOCUSING. Kapchinskii, I. M.; Teplyakov, V. A. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). 1969. 16p. (In Russian). Dep. CFSTI (U. S. Sales Only).

A linear ion accelerator with high frequency focusing and acceleration is proposed. The high frequency electric field is formed by a four-conductor line. There are no drift tubes in the accelerator. The advantages of the proposed accelerator are–relatively simple equipment, small transverse sizes and a possibility to lower the injection energy while keeping the intensity of the accelerated beam on the high level. (auth)

10868 (LNF-69/52) ON THE BUNCH LENGTHENING EFFECT IN STORAGE RINGS. Note No. 449. Lebedev, A. N. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). 15 Jul 1969. 12p. Dep. CFSTI (U. S. Sales Only).

The excitation of internal coherent synchrotron oscillations is considered as a possible origin of the collective longitudinal instabilities inside on rf bunched beam. The model of a straight orbit in a straight vacuum chamber is treated, so that a non-

symmetric field related to a finite conductivity of walls is solely responsible for the excitation of coherent oscillations. (W.H.K.)

10869 (SLAC-Trans-106) DAMPING OF COHERENT BEAM OSCILLATIONS IN A STORAGE RING. 1. BETATRON EXCITATIONS. Derbenev, Ya. S.; Dikanskii, N. S. (Akademiya Nauk SSR, Novosibirsk. Institut Yadernoi Fiziki). Translated by T. Watt (Stanford Linear Accelerator Center, Calif.), from Preprint No. 315. 38p. Dep. CFSTI.

The dynamics of small coherent betatron excitations of a beam circulating in a chamber with a doubly connected waveguide and with both ends of the waveguide loaded with an impedance equal to the wave impedance are studied. It is shown that one-dimensional excitations of any multipolarity are damped, and expressions are obtained for the damping rates in the case of homogeneous and bunched beams. It is seen that the estimated damping time constant for dipole oscillations is in good agreement with the experimental fast-damping time for the VEPP-2. It is also shown that two-dimensional excitations (r,z) are unstable for certain ratios of transverse dimensions and betatron frequencies. (W.H.K.)

10870 (UCRL-18980) SURVEY OF EXTERNAL INJECTION SYSTEMS FOR CYCLOTRONS. Clark D. J. (California Univ., Berkeley. Lawrence Radiation Lab.). Oct 1969. Contract W-7405-eng-48. 39p. (CONF-690921-2). Dep. CFSTI.

From International Cyclotron Conference. Oxford, England.

Internal cyclotron ion sources produce large currents of light ions such as protons, deuterons, and α-particles. But for many other ions an internal ion source is either impossible or of low intensity. Sources of polarized ions are much too large to put in the center of a cyclotron. To make heavy ions with the high charge states necessary for high cyclotron energy, the ion source needs high arc power input, which is supplied more easily in an external source. For negative ion acceleration, high gas flow and low pressure are needed, indicating the advantage of an external source. For these ions a number of groups have built or are planning injection from external sources. For polarized beams a few installations have used neutral beam injection. However, most polarized beam systems and all heavy ion and negative ion systems use ion injection because of better beam control during transport, and no loss of beam in charge exchange. The ion beams are brought in either axially through the magnet pole, or radially along the median plane. The larger cyclotrons being planned for 200–500 MeV provide adequate space in the usually crowded center region, for transport and inflection of beams from external injection systems. The various external injection systems operating or under construction for cyclotrons up to 500 MeV are compared and summarized. (auth)

10871 (UCRL-19367) SHIELDING MEASUREMENT AT THE CERN 25-GeV PROTON SYNCHROTRON. Gilbert, W. S. (California Univ., Berkeley. Lawrence Radiation Lab.). 20 Oct 1969. Contract W-7405-eng-48. 21p. (CONF-691101-11). Dep. CFSTI.

From International Conference on Accelerator Dosimetry and Experience, Stanford, Calif.

An outline is presented on shielding measurements at the CERN synchrotron using 14.6 and 26.4 GeV/c protons. (W.H.K.)

10872 (UCRL-19374) RADIATION MEASUREMENTS AND SHIELDING STUDY OF THE BERKELEY 27-INCH ^{3}He CYCLOTRON. McCaslin, Joseph B.; Smith, Alan R. (California Univ., Berkeley. Lawrence Radiation Lab.). Oct 1969. Contract W-7405-eng-48. 13p. (CONF-691101-10). Dep. CFSTI.

From 2nd International Conference on Accelerator Dosimetry and Experience, Stanford, Calif.

The 27-inch ^{3}He cyclotron was designed and constructed at LRL-Berkeley for use mainly in isotope production and activation analysis. Beam particle energy is 6 MeV/nucleon. Activation detectors and nuclear emulsions were exposed to secondary radiations produced by an internal beam of $\approx$1 μA striking a thick copper target. Moderated indium foils, the reactions ^{27}Al(n,α)^{24}Na, ^{19}F(n,2n)^{18}F, and ^{12}C(n,2n)^{11}C, and emulsions provided the information on neutron yield and spectral shape at this beam intensity from which shielding estimates were made for full beam intensity operation of $\approx$40 μA. The radiation levels, detector techniques, and shielding computations are discussed. (auth)

10873 (UCRL-19398) LOWER BOUNDS ON RING SELF-FOCUSING SO AS TO MAINTAIN RING INTEGRITY DURING SPILLOUT AND SUBSEQUENT ACCELERATION. Pellegrini, Claudio; Sessler, Andrew (California Univ., Berkeley. Lawrence Radiation Lab.). 4 Nov 1969. Contract W-7405-eng-48. 23p. Dep. CFSTI.

Relationships necessary for ring stability are derived between the self-focusing forces of an electron ring and the magnetic field gradient defocusing forces present near and just subsequent to spillout. (auth)

10874 (UCRL-Trans-1401) STATIONARY STATE OF A POLARIZED SELF-FOCUSING RING (ACCELERATION OF AN ELECTRON-ION BUNCH). Perel'shtein, E. A.; Yarkovoi, O. I. (Joint Inst. for Nuclear Research, Dubna (USSR)). Translated by T. Watt for Univ. of California, Lawrence Radiation Lab., Livermore, from report JINR-P9-4423. 26p. Dep. CFSTI.

The acceleration of a self-focusing electron-ion bunch is discussed. It is shown that when the self-focusing condition, including an allowance for gravitational forces in the uniformly accelerated (Møller) coordinate system, is satisfied, the ring can assume a stationary state. A particular mathematical model of this type of ring is developed. (auth)

10875 (UJV-2262-A) THE EFFECT OF INSULATOR SHAPE ON THE ELECTRIC STRENGTH OF A SECTION OF ACCELERATING TUBE IN A VAN DE GRAAFF ACCELERATOR. Dzmuran, R. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). Sep 1969. 42p. Dep. CFSTI (U. S. Sales Only).

Results of the tests of the effect of the insulator internal wall shape on the dielectric-strength of the gap in the accelerating tube are reported. The experiments were aimed to investigate the behavior of the gaps in the whole load range and to obtain the results which could be used in actual applications. Even though the results are affected by a number of parameters which were not studied, they show clearly that the insulator shape affects essentially the dielectric strength of the gap conditioning rate and efficiency, current load in the conditioning process, and the gap life. (auth)

10876 A SIMPLE THERMO MECHANICAL LEAK VALVE. Naylor, H. (Univ. of Auckland, New Zealand). Nucl. Instrum. Methods; 76: 357(1969).

A valve suitable for use with ion sources or gas targets, is described and details of throughput, power requirements and response time are given. (auth)

10877 END EFFECTS IN FIRST-ORDER THEORY OF QUADRUPOLE LENSES. Lee-Whiting, G. E. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Nucl. Instrum. Methods; 76: 305-16(1969).

Rapidly convergent series for the transverse position coordinates of a charged particle moving through an end zone of a quadrupole lens are derived by iterating integral equations obtained from the first-order differential equations. Not more than three terms of the series appear to be needed for lens strengths normally used. The series contain form-factors formed by integrating the field gradient along the axis with various weight functions. The focal lengths and the principal-plane coordinates of the whole lens are expressed in terms of numerically well behaved functions of the form-factors. Formulae are also derived for the effective lengths and strengths of the lens. (auth)

10878 CALCULATION OF PARTICLE TRAJECTORIES IN A CYCLOTRON AXIAL INJECTION SYSTEM WITH AN ELECTROSTATIC DEFLECTOR. Hazewindus, N. (Philips Research Labs., Eindhoven, Netherlands). Nucl. Instrum. Methods; 76: 273-7(1969).

Analytical formulas are presented describing particle trajectories through an axial ion injection system for a compact cyclotron. They are compared with results from numerical integration of the equations of motion. (auth)

10879 EXPERIMENTAL RESULTS ON NON RESONANT BEAM BREAK-UP EFFECTS IN A SUPERCONDUCTING STRUCTURE. Mittag, K.; Kuntze, M.; Heller, F.; Vetter, J. E. (Univ., Karlsruhe, Ger. Kernforschungszentrums, Karlsruhe, Ger.). Nucl. Instrum. Methods; 76: 245-52(1969).

The beam current in a superconducting proton linear accelerator is theoretically limited by oscillations in longitudinal and deflecting modes excited by the beam. Measurements of non-resonant excitation of rf modes in a superconducting proton linear accelerator structure by a continuous beam are reported. In particular excitation functions of modes in the accelerating passband close to the π-mode, starting currents and the frequency shift caused by the continuous beam were measured. The results are in quantitative agreement with the theoretical predictions. Oscillations in TM_{11}-like (deflecting) modes were observed, too. (auth)

10880 QUADRUPOLE-OCTOPOLE LENSES. Yavor, S. Ya.; Fishkova, T. Ya.; Shpak, E. V.; Baranova, L. A. (Ioffe Inst. of Physics and Tech., Leningrad). Nucl. Instrum. Methods; 76: 181-91(1969).

The formulae for the coefficients of the third-order spherical aberration of a quadrupole lens system are presented. Conditions for the correction of spherical aberration of different quadrupole and round lens systems by means of octopoles have been obtained. A new type of electrostatic quadrupole lens is suggested. The

experimental results are in good agreement with the calculated ones. (auth)

10881 A REFRIGERATED GAS TARGET APPARATUS FOR 180° ELECTRON SCATTERING. Fagg, L. W.; Jones, E. C. Jr.; Bendel, W. L. (Naval Research Lab., Washington, D. C.). Nucl. Instrum. Methods; 77: 136-40(1970).

A gas target system for use with 180 electron scattering experiments is described. The target gas is cooled to 77°K and maintained at about 4.4 atm with 6 μm havar foils separating the gas from the vacuum of the main target chamber. A gas transfer feature using liquid helium trapping is employed. The successful use of this apparatus in experiments with ^{20}Ne, ^{3}He, and ^{4}He is discussed. Salient features of an improved gas target design, now being tested, are also given. (auth)

10882 EXPERIMENTS IN THE LONGITUDINAL PHASE SPACE WITH THE CERN ELECTRON STORAGE AND ACCUMULATION RING (CESAR). Brueckner, A.; Huebner, K.; Jones, E.; Koziol, H.; Magnani, L.; Pentz, M. J. (CERN, Geneva). Nucl. Instrum. Methods; 77: 78-92(1970).

The most important of the experiments concerning the longitudinal phase space performed with the CERN electron storage ring model is described and the results are confronted with theory. The "stacking efficiency" for the accumulation of a large number of sequentially injected pulses into a stack was measured as a function of the number of pulses for two filled buckets per pulse as well as for one filled and one suppressed bucket ("missing bucket" scheme). The observation of anomalies in stacking experiments led to a diffusion model for the bucket separatrix in the presence of frequency noise and a series of experiments confirmed this theoretical model. Radiofrequency trapping experiments revealed the fact that during the first 2 ms after injection a strong blow up of the energy spread, from initially 0.3 keV to about 2 to 7 keV, occurred. (auth)

10883 EXPERIMENTS IN THE TRANSVERSE PHASE SPACE WITH THE CERN ELECTRON STORAGE AND ACCUMULATION RING (CESAR). Huebner, K.; Jones, E.; Koziol, H.; Magnani, L.; Pentz, M. J.; Ruggiero, A. (CERN, Geneva). Nucl. Instrum. Methods; 77: 93-104(1970).

The effect of nonlinear betatron resonances on the lifetime of an accumulated electron beam was determined. Coherent vertical oscillations of a coasting beam were investigated. The growth rates and the thresholds for the modes n = 2, 3, 4, 5 were measured. A time correlation between the different modes was established. It was tried to influence the oscillations by making the clearing field electrodes resonate with the beam. (auth)

10884 THE INFLUENCE OF AN INHOMOGENEOUS MAGNETIC FRINGING FIELD ON THE TRAJECTORIES OF CHARGED PARTICLES IN A THIRD ORDER APPROXIMATION. Matsuda, H.; Wollnik, H. (Justus Liebig-Univ., Giessen, Ger.). Nucl. Instrum. Methods; 77: 40-54(1970).

The deflection of charged particles in the "extended fringing field" of a magnet formed by conical pole faces is investigated. Effects originating from an oblique and curved field boundary are taken into account. All radial effects are calculated in a third order and all axial effects in a second order approximation, since in the radial direction a magnet can accept larger aperture angles than in an axial one. (auth)

10885 INVESTIGATION OF PARTICLE DYNAMICS IN 70 GeV PROTON SYNCHROTRON AT THE INSTITUTE OF HIGH ENERGY PHYSICS. Ado, Yu. M.; Myae, E. A. At. Energ. (USSR); 27: 515-23(Dec 1969). (In Russian).

The main results of investigation of particle movement in the IHEP Proton synchrotron, made from October 1967 to November 1968, are presented. These investigations resulted in an increase of the intensity of the beam up to about 10^{12} p.p.p. The highest energy of the protons, obtained in the accelerator, is 76 GeV. Without any correction of magnetic field, distortions of the equilibrium orbit at injection were ±5 cm radially and ±2 cm axially. After the magnetic field corrections the distortions of the orbit decreased to ±1.5 cm for r—direction and ±1 cm for z—direction. At the average and high fields, distortions of the orbit do not exceed ±1 cm, so correction of these fields was not carried out. During the first revolution with an injection current of 60 ma, particle losses are about 5% in the injection beam channel. The injection of protons into the accelerator is performed during one revolution with RF accelerating voltage. The efficiency of capture into the synchrotron regime is ~40% at limited speed of magnetic field rise at the beginning of the acceleration cycle. During first (10 to 15) msec, there are losses of ~30% of the particles, captured in acceleration. Further on no considerable losses are observed, including the region of transition energy and the region of high fields. A shift of betatron oscillation frequency to the value $Q_{z,r} = 9.8$ at injection results in considerable increase of accelerator intensity (~2 times). The stability region of the accelerator was investigated with the help of a correction gradient of the magnetic field. It was found that resonances of betatron oscillations up to the third order considerably decrease the intensity of accelerated beam. (auth)

10886 VACUUM SYSTEM OF PARTICLE ACCELERATING SYSTEMS. Pasztor, Endre. Finommechanika; 8: 300-2 (Oct 1969). (In Hungarian).

The collisions, free path distance, vacuum breakdowns, and the pressure effect are discussed, and it is seen that research in this area should be conducted along the following lines: the nature and electrode system of the accelerating process, control of beam scattering in controlled vacuum, determination of the conductivity of the entire system, and the design or selection of optimally performing vacuum pumps. (JPRS)

10887 APPLICATION OF INTEGRATED CIRCUITS IN NUCLEAR INSTRUMENTATION. Meirsschaut, Simon (Univ., Ghent). Rev. H. F. (Brussels); 7: 177-82(1968). (In French).

An apparatus is described that records the maximum of the average beam intensity of the proton synchrotron at CERN (Geneva), the average being taken over ten or one hundred cycles of the accelerator. The apparatus has been realized by means of integrated circuits. (auth)

10888 MALFUNCTION ALARM ANNUNCIATOR. Cheeseman, P. R. (to United States Atomic Energy Commission). U. S. Patent 3,484,770. 16 Dec 1969.

Malfunction alarm and annunciator systems for high energy charged particle accelerators are described. Memory means comprise modules with transistors forming selective conductive states and silicon controlled rectifiers responsive as a memory to these conduction states for the annunciation thereof. (AEC)

10889 INVESTIGATION OF A LINEAR PLASMA BETATRON. Lutsenko, E. I.; Fainberg, Ya. B.; Vasilchuk, V. A.; Shepelev, N. P. (Physical-Technical Inst., Kharkov). Zh. Eksp. Teor. Fiz.; 57: 1575-84(Nov 1969). (In Russian).

The problem of obtaining intense electron beams in plasma, uniform or nonuniform along the length, is investigated. Under the conditions of the experiment, restricted electron emission from the cold cathode resulted in a redistribution of the electric field applied to the plasma in the region near the cathode. In this case an intense electron beam with an energy corresponding to the applied voltage is produced. The beam–plasma interaction which arises results in loss of approximately a third of the beam. The remaining part leaves the accelerator and can be utilized. Application of a plasma with a concentration drop in the direction of motion of the beam results in a sharp decrease of efficiency of the beam-plasma interaction. The beam losses become smaller and the electron energy spectrum narrower. (auth)

10890 OUR 8 MeV LINEAR ACCELERATOR. Hornung, R. Sulzer Tech. Rev.; 51: 53-62(1969).

The design, construction and operation of a high-energy x-ray facility, which uses an 8 MeV linear accelerator for testing large thick-walled components (castings, forgings, and weldments) for machines and nuclear reactors, are discussed. Use of the linear accelerator resulted in x rays of steel objects with wall thicknesses from 50 to 500 mm that had high fault resolution, excellent picture contrast, and above average picture quality. The most important application for the linear accelerator is the x-ray testing of thick-walled castings. The procedure can begin as soon as the castings come out of the sand. The casting quality can be continuously monitored. The ability to reject unsatisfactory pieces in the initial production stage results in economic savings and higher quality products. (L.C.L.)

PHYSICS (NUCLEAR)

Neutron Interactions with Matter

Refer also to abstracts 9723, 10478, 10609, and 10636.

10891 (AD-694513) MILLIMETER AND NANOSECOND RESOLUTION OF FAST NEUTRONS FROM AN INTENSE PLASMA DISCHARGE. Report for May 1968-February 1969. Bernstein, Melvin J. (Aerospace Corp., El Segundo, Calif.). 1 Jul 1969. Contract F04701-69-C-0066. 20p. (TR-66(5220-50)-6; SAMSO-TR-69-297). CFSTI.

Polyethylene collimators have been used with fast photomultipliers to spatially resolve the source of 2.45 MeV neutrons in a pulsed, dense, high-temperature, deuterium plasma. The axial distribution of the neutron source was measured with a spatial resolution of 2 mm and a time resolution of 3 nsec. A time-of-flight technique was developed to measure the average neutron velocity with just one photomultiplier and two widely separated plastic scintillators. (auth)(USGRDR)

10892 (CONF-680461-4) STANDARD FLUX OF THERMAL AND EPI-THERMAL NEUTRONS. Mijnheer, B. J.; Aten, A. H. W. Jr. (Instituut voor Kernphysisch Onderzoek, Amsterdam (Netherlands)). [nd]. 5p. Dep. CFSTI (U. S. Sales Only).

From Professional Commission on Nuclear Physics, Bad Neuenahr, Germany.

The requirements for a standard neutron flux permitting measurements with bulky instruments are discussed. A standard flux for epithermal neutrons using an Am-Be source is described. (J.W.R.)

10893 (DR/SAR-G-67-45) MODERATION OF NEUTRONS FROM POINT SOURCES APPLICATION: NEUTRON RADIOGRAPHY (A SUMMARY OF THE PRESENT POSITION). Barton, J. P. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Dec 1967. 9p. Dep. CFSTI (U. S. Sales Only).

A review is given of some information about thermal neutron fluxes obtainable from accelerator and radioactive neutron sources. It is pointed out that for the particular application of neutron radiography the adoption of the divergent collimator principle leads to the requirement of a highest peak local flux. A high flux, spread out over a large volume of moderator is of no advantage. Values of peak local thermal flux obtained in paraffin or water moderator using D-T accelerators and an $^{241}Am-Be$ radioactive source at GRENOBLE give a ratio of 1000 between fast 4π output and thermal neutron flux, e.g., a source of output 10^{10}N/sec at 14 MeV gives a peak thermal flux of 10^7 n/cm^2 sec. If the peak thermal flux could be increased, it would be of considerable importance to neutron radiography. Various details of information are listed which indicate that improvement may be possible. (auth)

10894 (IFA-FR-77) FAST AND RESONANCE NEUTRON SPECTRUM IN WATER AND GRAPHITE. Grancea, I.; Cuculeanu, V.; Iosif, V. (Academia R. S. R., Bucharest. Institutul de Fizica Atomica). 1969. 12p. Dep. CFSTI (U. S. Sales Only).

Fast neutron spectra in water and graphite were measured using threshold detectors. The resonance neutron spectra were measured by another method. (J.W.R.)

10895 (INP-677) MOLECULAR INTERACTION EFFECT IN NEUTRON SCATTERING BY GASEOUS METHANE. Fulinski, A.; Janik, J.; Blocki, J. (Institute of Nuclear Physics, Krakow (Poland)). Sep 1969. 17p. Dep. CFSTI (U. S. Sales Only).

A correction to the translational part of the scattering function $S^{tr}(Q,\omega)$ caused by molecular interaction in CH_4-gas is evaluated. It is shown that the Lenard-Jones form of the interaction potential causes a decrease of the peak value of S^{tr}-function. (auth)

10896 EFFECT OF ACCELERATION OF THE MEDIUM ON NEUTRON SPECTRA. Kostritsa, A. A.; Neimotin, E. I. Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat.; No. 2, 39-44(Mar-Apr 1969). (In Russian).

An approximate method for calculating the density and spectrum of neutrons in systems undergoing acceleration is presented. The kinetic equation for a homogeneous medium of heavy nuclei with an evenly distributed source is given. (L.T.W.)

10897 APPLICATION OF GREEN'S FUNCTION ANALYSIS TO THE SOLUTION OF THE NEUTRON DIFFUSION EQUATION IN HETEROGENEOUS SYSTEMS. Banks, Norman Earl. Morgantown, W. Va.; West Virginia Univ. (1968). 158p.

Thesis.

The general time-dependent, one-velocity neutron diffusion equation is formulated in generalized three-dimensional coordinates for bare heterogeneous systems containing N very thin heterogeneities. This diffusion equation is written first in the Heaviside notation and subsequently transformed to a Dirac delta function representation. Green's function integral techniques are then applied to determine its solution. As an introduction to the Green's function method of solution, the time-independent system is solved in slab, spherical, and cylindrical geometries. For the case of a single heterogeneity in these systems, correlations between the materials and geometric bucklings of sub-critical, critical and super-critical systems are graphically presented and discussed. Numerical examples are given for each geometry and comparisons are made among this work, exact multiregion diffusion theory, and a special application of one-group perturbation theory. Good agreement is obtained between the present theory and exact multiregion theory in all cases investigated; however, in cases where the heterogeneity is highly absorbing the limitations of perturbation theory are exceeded, and it is found that perturbation theory gives very poor results. To further demonstrate the versatility of the Green's function method, the theoretical flux solution and critical condition of a reactor system containing N control rods are outlined, and the critical condition is derived explicitly for the case of N = 1. The time-dependent non-multiplying system is then solved by Laplace transforming the time variable, and the condition which determines the eigenvalues of the time-dependent system is shown to be closely related to critical systems having the same values for the relative properties between the heterogeneities and the surrounding medium. The feature of this work is the solution which is subsequently obtained for the time-dependent multiplying system where delayed neutrons are taken into account by the one-delayed-group approximation. It is found that two complete sets of decay constants are present in the decay of the neutron population of the system. One decay constant has a large negative value and is associated with the prompt neutron die-away, while the other, which is representative of the effect delayed neutrons have upon the system is of the order of λ, the reciprocal of the one-delayed-group mean life. Finally, a method and numerical example are presented to determine the degree of off-criticality for a given heterogeneous system associated with an experimental measurement of the value of the prompt neutron pulse injected into the system. Using the relation between the prompt decay constant and the materials buckling of the system, the effective multiplication factor can be determined. (Diss. Abstr.)

10898 MEASUREMENTS OF TIME-DEPENDENT NEUTRON SPECTRA IN H_2O. Menzel, Joerg Hanns. Troy, N. Y.; Rensselaer Polytechnic Inst. (1969). 273p.

Thesis.

The phased chopper-Linac technique combined with an on-line Programmed Data Processor (PDP-7) was used to measure time-dependent neutron spectra in the center of an externally pulsed 7.16 × 25.02 × 25.4 cm water medium at 37.8°C. The experimental energy region is 0.01 eV < E < 0.25 eV and the time scale extends from approximately zero to 100 μsec. In order to be able to follow the rapidly changing behavior of neutrons in a pulsed water medium with adequate time resolution and reasonable counting rate a unique dual-disk neutron chopper was designed and used. Experimental results are presented in the form of the time behavior of neutrons at various energies (neutron life histories), time moments, time-dependent spectra at various times, the steady state spectrum, energy and velocity moments, and the time behavior of the Non-Maxwellian portion of the time-dependent spectra. Due to spatial harmonics, the rate of decay implied by the neutron life history curves for t > 30 μsec is only three-fourths of that corresponding to the fundamental decay constant for the medium under investigation. The results of a harmonic analysis based on cadmium covered gold foil activations along the three axes of the water slab are in complete agreement with spatially dependent die-away measurements for 150 μsec < t < 900 μsec and the neutron life histories at the medium center of 40 μsec < t < 100 μsec. The average velocity of the experimental spectrum at t = 23 μsec is within 2% of the average velocity corresponding to a Maxwellian distribution, and the 35 μsec spectrum is shown to fit a Maxwellian at the medium temperature. This indicates that the thermalization process in water is essentially complete in 23 μsec. Time-dependent diffusion theory calculations using a 78-group Haywood-II plus mass-16 free gas oxygen kernel were performed with and without spatial harmonics. The inclusion of higher spatial modes affects the amplitude of the time-dependent spectra by 20% or more but in-

creases the spectral shape at the high energy side by only 2–3%; the average energy increases by only about 1% for the time range 5 μsec < t < 60 μsec. The results of the theoretical calculation of time dependent spectra in the center of the water slab, which included the effect of spatial harmonics via B^2 leakage terms, do not agree with the experimental results; time-dependent diffusion theory predicts a rate of thermalization which is faster than that observed experimentally. The discrepancy is probably due to the inadequacy of time-dependent diffusion theory and indicates the need for higher approximations to the Boltzmann equation as well as a more complex treatment of spatial harmonics in order to predict time-dependent spectra in an externally pulsed water system. (Diss. Abstr.)

10899 INELASTIC SCATTERING OF SLOW NEUTRONS BY SOLID AND LIQUID HYDROGEN. Schott, Wolfgang (Technische Hochschule, Munich. Kernforschungszentrum, Karlsruhe, Ger.). Z. Phys.; 231: 243-65(1970). (In German).

Para-ortho transitions in solid hydrogen above the λ-point have been measured by inelastic neutron scattering. From the scattered spectra the widths of the rotational lines caused by the quadrupole-quadrupole interaction between the ortho-molecules are determined. The full width at half intensity is found to be 1.22 ± 0.07 and 0.80 ± 0.07 MeV for 68 and 27 percent ortho-concentration respectively in good agreement with theoretical values. The phonon spectrum of solid hydrogen could be extracted from the neutron scattering data. The specific heat and the Debye temperature which were calculated from the phonon spectrum are in fairly good agreement with experimental values. Moreover, the double differential scattering cross section of liquid hydrogen (T = 19.8°K) was measured at 87 and 21.8 MeV incident neutron energy. In the case of 87 MeV energy there is a relatively good agreement with a simple free rotator model. At 21.8 MeV the binding of the molecules in the liquid influence the spectrum. Therefore, a description of the measured spectrum by a convolution of the phonon spectrum of the solid and a simple diffusion model was tried. This model is superior to the gas model but discrepancies between model and experiment still remain. (auth)

10900 RE-ENTRANT HOLE EFFECTS IN PULSED-NEUTRON EXPERIMENTS. McGirt, Albert Franklin, Jr. Troy, N. Y.; Rensselaer Polytechnic Inst. (1969). 288p.

Thesis.

One problem of concern in pulsed neutron experiments is the influence of a re-entrant hole on the quantity being measured. An analytical procedure was developed which will give a quantitative as well as a qualitative description of re-entrant hole effects in both thermal and fast assemblies. The calculational model assumes slab geometry for the unperturbed situation and considers cylindrical holes of various diameters and depths. The two-dimensional nature of the hole is represented by a wall-streaming term which is used as a boundary condition for a reduced effective slab. The effective slab geometry is obtained by reducing the thickness of the original slab by an amount equal to the depth of the re-entrant hole. The validity of this important simplification is confirmed by results of two-dimensional discrete ordinates transport calculations in which the re-entrant hole is explicitly introduced. A second basic assumption used to simplify the numerical calculations is that the flux along the walls of the re-entrant hole is adequately represented by the unperturbed flux. This approximation is judged valid by the success of the method in predicting experimental results. The numerical application of the analytical procedure is made using both discrete S_n transport theory and diffusion theory. The transport theory solutions are obtained from a code system which makes use of a standard production program DTF-IV as a subroutine for performing both unperturbed and perturbed effective slab calculations. One group diffusion theory results are acquired from the computer code HOLPERT written especially for this re-entrant hole analysis. In applying the model to moderators for the calculation of re-entrant hole distortion in time-asymptotic spectrum measurements or to fast assemblies for steady-state spectra, two major causes of re-entrant hole distortion are found. The most important effect is due to the penetration of the re-entrant hole through regions of differing flux gradients. A second effect is due to actual leakage of neutrons from the medium by way of the void. In certain situations these effects are found to be both additive and compensative. Extensive time-asymptotic spectrum calculations are made for water and compared to experiment. Very little spectrum distortion is observed which is due to the large degree of space-energy separability present in the unperturbed problem. However, the amplitude is perturbed, and the amount of distortion is found to be a direct function of the hole depth, hole radius, and slab thickness. For all cases of comparison of theoretical and experimental results, the discrete S_n transport theory model is able to predict the experiment to about five percent, and in most cases even more accurately. Diffusion theory is somewhat less accurate but still useful for one-group estimates or survey calculations of the type included in this work for graphite, heavy water, and beryllium moderators. The one-dimensional transport theory model is also used for steady-state fast spectrum calculations in iron, depleted uranium and an iron-depleted uranium interface problem. Large distortions up to ten percent or more are observed for all three media, with the detailed cross section of each material playing a major role in determining the exact magnitude of the re-entrant hole effect. (Diss. Abstr.)

10901 INELASTIC SCATTERING IN LIQUID SODIUM AT SMALL MOMENTUM TRANSFER. Randolph, P. D. (Idaho Nuclear Corp., Idaho Falls). pp 449-56 of Neutron Inelastic Scattering. Vol. I. Vienna; International Atomic Energy Agency (1968).

From Symposium on Inelastic Neutron Scattering, Copenhagen, Denmark. See STI/PUB-187(Vol.1); CONF-680501-(Vol.1).

The small momentum transfer region in simple liquids is of particular interest from the standpoint of examining the approach to the hydrodynamic limit and for studying diffusive and collective excitations. Measurements are reported on the inelastic scattering of slow neutrons from a sample of liquid sodium at 102°C in the κ region below the first diffraction maximum. The experiment was performed with the MTR phased chopper velocity selector at incident energies of 30 and 51 MeV. To remove air scattering, an evacuated flight path subtending an 18.3° range of scattering angles was used. The measured spectra span the momentum transfer range ħκ of $0.3 \leq \kappa \leq 1.4$ Å^{-1} and an energy transfer range of $0 \leq \hbar\omega \leq 30$ MeV. The quasi-elastic scattering was analyzed after correction for coherent scattering and multiple elastic scattering. The behavior is solid-like with a Debye–Waller coefficient of 0.22 Å^2. The widths of the quasi-elastic peaks are narrower than predicted by the simple diffusion model, but are in agreement with the jump-diffusion model with a residence time τ_0 of 1.5×10^{-12} sec. A broad peak or shoulder in the inelastic scattering appearing in all scattering angles at an energy transfer of 14 MeV is primarily due to incoherent inelastic scattering. Its shape is in agreement with a Debye frequency spectrum but beyond the cut-off shows evidence of multiple inelastic scattering. (auth)

10902 CRITICAL SCATTERING OF POLARIZED NEUTRONS IN FERROMAGNETS. Kocinski, J.; Wentowska, K. (Warsaw Tech. Univ.). Acta Phys. Pol.; 36: 697-705(Oct 1969).

The following theory of magnetic critical scattering differs from the conventional one, initiated by Van Hove and developed by other authors mainly in the two respects: (1) It is based on the model of the scattering system which reflects the system's inhomogeneity for temperatures in the vicinity of the critical point, while the conventional treatment implies homogeneity of the system and (2) It operates with two forms of the instantaneous spin correlation, the Ornstein–Zernike form–applied also in the conventional theory, and the $|\sin \varkappa_2 r|/r$ form. The theory would represent a simple generalization of the approach developed earlier for temperatures above the Curie point, to temperatures below but close to the critical, with external field present and polarized incoming neutrons, were it not for the essential modification: It consists in the simultaneous application of both the spin correlations to the description of the scattering system. Now, the Ornstein–Zernike form describes the correlation of spins of the background, while the the $|\sin \varkappa_2 r|/r$ form the correlation of spins in the regions of the system with highly abnormal fluctuations, while in the earlier exposition these correlations were treated as alternatives. (auth)

10903 YIELDS AND SPECTRA OF SOME SPHERICAL PHOTO NEUTRON SOURCES. Bensch, F.; Vesely, F. (Oesterreichische Hochschule, Vienna). J. Nucl. Energy; 23: 537-50 (1969).

Six types of spherical photoneutron sources (Sb–Be, Ga–D_2O, Na–D_2O, In–Be, La–Be, Na–Be), each emitting neutrons within a narrow energy range, were investigated. All γ-samples required could be produced in a nuclear reactor. The neutron yield (neutrons/Ci) was stated with a mean error of 2.4 per cent, only in the case of In–Be this error is 3.5 per cent and in the case of La–Be 4.6 per cent. The neutron yields of Sb–Be sources were determined for several target thicknesses and experimental self-shielding factors are derived therefrom. An attempt was made to find a general relation between the activity of the γ-sample, the target quantity and the neutron yield. A Monte Carlo routine was employed to determine the neutron emission spectrum as well as to confirm the experimental results. Therefore, it was possible to procure sources of almost monoenergetic neutrons particularly suitable for cross section measurements and detector calibration. (auth) (UK)

10904 APPROXIMATE TREATMENTS OF NEUTRON WAVE PROPAGATION PROBLEMS IN THREE-DIMENSIONAL SYSTEM.

Yamagishi, Tomejiro (Osaka Univ.); Tezuka, Masaji; Sekiya, Tamotsu. J. Nucl. Sci. Technol. (Tokyo); 6: 611-21(Nov 1969).

Neutron wave propagation problems, especially the Milne and the albedo problems, are investigated by making use of the Wiener–Hopf technique for treating the Boltzmann equation with an isotropic one-term degenerate kernel in a semi-infinite prism. A pole of the solution of the integral-transformed Boltzmann equation corresponds to an eigenvalue — or physically, to a complex wave number varying on the two-dimensional complex plane with transverse buckling and wave oscillation frequency. In the Milne problem, the solution ceases to exist when the imaginary part of the complex wave number exceeds Σ_{min}. In the albedo problem, however, the solution always exists irrespectively of the oscillation frequency ω, and the discrete eigenvalue presents a continuous spectrum as soon as ω exceeds a critical frequency ω_c. Detailed forms of solutions are derived for the case of constant velocity, and complex eigenvalues are evaluated numerically. (auth)

Nuclear Properties and Reactions, A≤ 5

Refer also to abstracts 9691, 10787, and 11026.

10905 TENSOR FORCE IN THE SEPARABLE POTENTIAL MODEL OF NEUTRON–DEUTERON COLLISIONS. Sloan, Ian H. (Univ. of New South Wales, Kensington). Nucl. Phys.: A139: 337-52(1969).

The collision problem for a model of the neutron–deuteron system with a tensor force has been reduced to a set of coupled one-dimensional integral equations. The model uses the central plus tensor separable potential of Yamaguchi for the triplet two-body interaction, and a rank-one, S-wave, separable potential for the singlet interaction. For $J > \frac{1}{2}$ the three-body problem is reduced to a set of four coupled equations for each parity, and for $J = \frac{1}{2}$ to three coupled equations for each parity. In the $J = \frac{1}{2}$ even parity case the equations are equivalent to those obtained by previous workers. (auth)

10906 EFFECTS OF ELECTROMAGNETIC RETARDATION IN PHOTODISINTEGRATION OF DEUTERON. Nunemaker, Rodney Dale. New Haven; Yale Univ. (1968). 293p.

Thesis.

Cross sections and the polarizations of the outgoing nucleons are calculated for the d(γ,n)p reaction for photon energies less than 180 MeV, using nonrelativistic quantum mechanics. Although meson exchange currents and electromagnetic form factors for the nucleons are not considered, all effects of retardation and of the nucleon magnetic moments on electric multipoles in the Hamiltonian for the interaction between the incident electromagnetic wave and the n-p system are taken into account and all possible final states resulting from transitions induced by all electromagnetic multipoles up to and including 2^4-poles are considered. A calculation of the effects of the recoil motion of the center of mass of the n-p system following absorption of a photon is described and numerical results indicating the magnitude of these effects are given. The nucleon-nucleon interaction is treated in terms of several different semiphenomenological two-nucleon potentials of both the hard-core and soft-core variety. Following a detailed description of these potentials, a modification of the Yale potential which predicts a lower deuteron D-state probability is developed. Comparisons of the theoretical results to the available experimental data are made, but it is found that it is not possible to distinguish any of the potentials as providing a fit to the data definitely superior to that of the others. The relative importance of the various electromagnetic multipole orders and of several different terms in the interaction Hamiltonian are studied and effects of including retardation are ascertained. Calculations involving polarized photons and deuterons illustrate the quite appreciable differences arising from the use of different internucleon potentials. (Diss. Abstr.)

10907 THE GAMMA-RAY ANGULAR DISTRIBUTIONS FROM THE REACTION D(p,γ)^{3}He BELOW 200 keV. Olivo, Miguel Angel. Vancover, B. C.; Univ. of British Columbia (1968).

Thesis.

The angular distribution of the gamma-rays from the direct radiative capture reaction D(p,γ)^{3}He was measured for 70 and 144 keV protons in the laboratory system, using thin deuterated polyethylene targets. The study of this particularly simple reaction is of interest for determining some properties of the forces which bind nuclear particles to each other. In addition it plays a role in a number of astrophysical processes. The ground state of ^{3}He is predominantly a symmetric ^2S state with admixtures of a ^4D state and a $^2S_{(m)}$ state of mixed symmetry. These admixtures are related to specific components of the two body forces coupling the three particles. The measurements were made with a high current 180-keV accelerator, built by the author, using an ORTEC duoplasmatron ion source. Technical problems involved in the development of the accelerator and the deuterated targets are discussed. The absolute cross section was not measured. Plans for measuring it in the near future are discussed briefly. (Diss. Abstr.)

10908 MAGNETIC MOMENT AND HFS ANOMALY FOR ^{3}He. Williams, W. L.; Hughes, V. W. (Yale Univ., New Haven). Phys. Rev.: 185: 1251-5(20 Sep 1969).

The ratio of the nuclear magnetic moments of ^{3}He and ^{1}H was measured by NMR techniques using a gaseous sample. The result is $-\mu_{^3He}(He)/\mu_p(H_2) = 0.76178685$ (±0.1 ppM), uncorrected for magnetic shielding in He and H_2, and with these shielding corrections, $-\mu_{^3He}/\mu_p = 0.76181237 \pm 0.6$ ppM. With this new value for the magnetic moment ratio the hfs anomaly is found to be $\delta_{^3He} = +(217 \pm 3) \times 10^{-6}$. By comparison with the theory for $\delta_{^3He}$ the contribution of exchange currents to $\delta_{^3He}$ is calculated to be $+(15 \pm 5) \times 10^{-6}$. (auth)

10909 EFFECTIVE α + α AND α + N POTENTIALS FROM RESONATING-GROUP CALCULATIONS. Thompson, D. R. (California Inst. of Tech., Pasadena); Reichstein, I.; McClure, W.; Tang, Y. C. (Phys. Rev.; 185: 1351-61(20 Sep 1969). Contract AT(11-1)-1764.

The method of the resonating-group structure is used to study the α + α and α + N systems. With a nucleon-nucleon potential of a near-Serber exchange mixture, it was found that good agreement with the empirical phase-shift data can be obtained. Using the resultant radial scattering functions, effective potentials between the clusters are derived, which yield the same phase shifts as does the resonating-group calculation. These potentials are quite similar to the phenomenological potentials obtained by Ali and Bodmer, and Darriulat et al. in the α + α case and by Swan and Pearce in the α + N case. They consist of a hard core with a radius which is weakly energy-dependent but strongly l-dependent and an attractive long-range part which has only a weak dependence on the relative orbital angular momentum and the energy in both even- and odd-l states. In addition, it is found that the long-range part has an odd-even feature which has previously been noted by Gammel and Thaler in their phenomenological study of the α + p scattering data, but has not been commonly considered in the usual local-potential approach to a scattering problem. Based on the experience here, an effective potential is also proposed for those cases where a straightforward application of the resonating-group method is impractical. (auth)

10910 MULTIPLE-SCATTERING ANALYSIS ON A SOLUBLE NEUTRON–DEUTERON MODEL. Sloan, Ian H. (Univ. of New South Wales, Kensington). Phys. Rev.; 185: 1361-70(20 Sep 1969).

The multiple-scattering series for elastic scattering is investigated numerically for a model of the neutron-deuteron system, at neutron laboratory energies of 14.1, 50, and 100 MeV. The model is that of Aaron, Amado, and Yam, with spin-dependent, s-wave, separable, two-body interactions. It is found that the doublet L = 0 series converges only slowly even at 100 MeV, and that it strongly diverges at 14.1 MeV. On the other hand, the convergence is rapid for both doublet and quartet partial waves beyond L = 2, and for these the single-scattering plus Born-pickup terms provide an accurate approximation. Differential cross sections and partial-wave amplitudes are given for various orders of multiple scattering, and for a unitary version of the first-order approximation, and are compared with the exact results. (auth)

10911 FURTHER STUDY OF α + α SCATTERING. Reichstein, I.; Tang, Y. C. (Univ. of Minnesota, Minneapolis). Nucl. Phys.; A139: 144-8(1969).

The α + α scattering problem is investigated with the resonating-group method in the one-channel approximation, using an improved nucleon–nucleon potential. The results are significantly better than those obtained in previous α + α calculations using this method. (auth)

10912 CALCULATION OF THE THERMAL NEUTRON CAPTURE CROSS SECTION OF MOLECULAR HYDROGEN. Rietschel, Hermann (Kernforschungszentrum, Karlsruhe, Ger.). Nucl. Phys.; A139: 100-7(1969).

The thermal neutron capture cross section of bound protons is known to be the same as for free protons. This was proved first by Lamb for all cases but one, i.e., when the binding partner was another proton likewise allowed to participate in the capture process. Interference phenomena due to Pauli's principle seemed possible and were found by measurements of Bryan on liquid

hydrogen in the ortho- and para-phase, respectively. Using fully antisymmetrized proton wave functions the author was unable to verify any such effect and obtained $\sigma_{cap}^{ortho} = \sigma_{cap}^{para} = \sigma_{cap}^{free}$ in contradiction to Bryan's result. (auth)

10913 EXPERIMENTAL STUDY OF THE REACTION $D(p,\gamma)p_s$, D at 156 MeV. Didelez, J. P.; Langevin-Joliot, H.; Duhamel, G.; Marcus, L.; Narboni, P. (Institut de Physique Nucleaire, Orsay, France). Nucl. Phys.; A139: 69-80(1969). (In French).

The radiative capture of 156-MeV protons by neutrons has been investigated using liquid deuterium as a "quasi-free" neutron target. The angular and momentum distributions of deuterons measured in coincidence with the emitted γ ray are in agreement with the distributions calculated in the impulse approximation. Photon differential cross sections are given for four angles and are found to be reduced by a factor 0.85 ± 0.20 from the values inferred from photodisintegration data. Experimental cross sections are compared with theoretical predictions for free capture. (auth)

Nuclear Properties and Reactions, 6≤A≤19

Refer also to abstracts 9691, 10941, 10942, 10970, 11026, and 11050.

10914 (ANU-P-476) ANALYSIS OF THE REACTION $^{31}P(p,p_0)$ IN THE ENERGY RANGE 8.0 TO 10.0 MeV. Dallimore, P. J.; Hellstroem, J. (Australian National Univ., Canberra. Research School of Physical Sciences). [1969]. 23p. Dep. CFSTI (U. S. Sales Only).

Absolute differential cross sections were measured for the elastic scattering of protons from ^{31}P. Excitation functions were measured for incident proton energies from 8.0 to 10.0 MeV in 10 keV steps at 14 angles and in 50 keV steps at 13 angles. The energy averaged angular distributions were analyzed using the optical-model and Hauser–Feshbach theories and the excitation functions were analyzed using the statistical theory of fluctuations. The fractions of direct reaction calculated by the two methods were compared and are in good agreement for values of $Y_D \gtrsim 0.8$. (auth)

10915 (IFA-CRD-40) ANGULAR DISTRIBUTION OF THE NEUTRON POLARIZATION FROM $^{11}B(\alpha,n)^{14}N$ REACTION, AT LOW ENERGY. Ciocanel, A.; Molea, M.; Pencea, C.; Salagean, O. (Academia R. S. R., Bucharest. Institutul de Fizica Atomica). 1969. 6p. Dep. CFSTI (U. S. Sales Only).

The measurement of the neutron polarization from the $^{11}B(\alpha,n)^{14}N$ reaction, at alpha particle energies of 3.6 and 3.8 MeV, was done to investigate the reaction mechanism and the level structure of the compound nucleus ^{15}N. A time-of-flight standard technique with improved radiation shielding and proper resolution was used. The preliminary analysis of the experimental data indicates the formation of the compound-nucleus ^{15}N with the participation of the $13.63(\frac{5}{2},\frac{7}{2})^-$, 13.70(?) and $13.79(\frac{5}{2})^+$ excited levels in ^{15}N. Subsequent calculation will make clear if the magnitude of the polarization is determined by the interference of these levels only, or if it will be necessary to take into account a ground term of the R-matrix, as well as a direct contribution, which is slowly changing with incident energy. (auth)

10916 (IFA-M-42) FINE STRUCTURE OF THE $^{12}C(\gamma,n)^{11}C$ CROSS SECTION. Baciu, G.; Catana, D.; Deberth, C.; Iliescu, C.; Cirstoiu, B. (Academia R.S.R., Bucharest. Intitutul de Fizica Atomica). 1969. 14p. Dep. CFSTI (U.S. Sales Only).

The cross section for the $^{12}C(\gamma,n)^{11}C$ reaction was measured from threshold to 25 MeV with a small energy bin (100 keV). The giant resonance was resolved into a very well defined triplet structure. It seems that the shape of the $^{12}C(\gamma,n)^{11}C$ cross section is influenced by the dipole-quadrupole coupling. (auth)

10917 (ORNL-tr-2243) INTRANUCLEAR CASCADES WITH ALLOWANCE FOR α-CLUSTERS. Barashenkov, V. S.; Abdinov, O. B. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). Translated for Oak Ridge National Lab., Tenn., from report JINR-P2-4568. 9p. Dep. CFSTI.

Intranuclear cascades in light nuclei are studied within the framework of the cluster model. Monte Carlo calculations were the intranuclear cascades following the interaction of 660-MeV protons with ^{12}C. The ^{12}C nucleus was assumed to be a uniform spatial distribution of α-clusters with a sharp nuclear boundary. The results are compared with available experimental data. (J.W.R.)

10918 CALCULATION OF THE QUADRUPOLE MOMENTS AND B(E2) VALUES OF ^{17}O AND ^{17}F WITH THE SUSSEX MATRIX ELEMENTS. Mavromatis, H. A.; Singh, B. (American Univ. of Beirut, Lebanon). Nucl. Phys.; A139: 451-64(1969).

The ground state quadrupole moments and $1s_{\frac{1}{2}} \rightarrow 0d_{\frac{5}{2}}$ B(E2) values of ^{17}O and ^{17}F are calculated. To obtain A = 17 wave functions the 1p–1h energy matrix for ^{16}O is first diagonalized yielding 2^+ vibrations of ^{16}O. These are then coupled to the single-particle states of the 1s–0d oscillator shell yielding 2p–1h states. Diagonalization is then performed of the A = 17 matrix which includes single-particle and these 2p–1h states. Two alternatives to diagonalizing the A = 17 energy matrix are also considered. One involves obtaining the ^{17}O and ^{17}F wave functions by using perturbation theory to couple the 2^+ vibrations to the 1s–0d single-particle states and the other, simpler still, consists in coupling noninteracting 1p–1h excitations via perturbation theory to the 1s–0d single-particle states. Both these are shown to give smaller results than the diagonalization procedure. The potential matrix derived at Sussex is used as the interaction and single-particle energies are calculated rather than taken from experiment. Thus the only free parameter used is the oscillator length b which is taken to be 1.7 fm. In the principal part of the calculation only the 0p holes are excited and these only through two oscillator shells. The effect of 0s holes is estimated. Comparisons are made with calculations involving the Kuo-Brown G-matrix and the G-matrix derived from the Tabakin interaction. (auth)

10919 TRANSVERSE FORM FACTORS OF ^7Li CALCULATED WITH PROJECTED HARTREE–FOCK WAVE FUNCTIONS. Kruger, J.; Van Leuven, P. (Rijksuniversitair Centrum, Antwerp. Studiecentrum voor Kernenergie, Mol, Belg.). Nucl. Phys.; A139: 418-24(1969).

Transverse magnetic and electric contributions to the high-energy electron scattering at 180° from the ground state and first excited state of ^7Li are calculated using projected Hartree–Fock wave functions obtained previously. The results are compared with experiment and with the LS coupling shell model. (auth)

10920 NUCLEAR REACTION STUDIES VIA THE REACTION (p,pn) ON LIGHT NUCLEI AND THE REACTION (d,pn) ON MEDIUM-TO-HEAVY NUCLEI. May, Edwin Charles. Pittsburgh; Univ. of Pittsburgh (1968). 66p.

Thesis.

Deuteron disintegration by Au, Rh, Cu, and C was studied with a p-n correlation technique. Angular distributions of protons coincident with neutrons are given and compared qualitatively with angular distributions expected from d disintegration in nuclear and Coulomb fields. Coulomb breakup is observed predominantly from high Z targets while nuclear breakup is observed predominantly from low Z targets. Neutron pickup experiments forming a deuteron in its S = 0, T = 1 state ($\bar{d}$) were studied via the (p,pn) reaction. The angular distributions of $\bar{d}$ from Li, Be, C, Mg, and Sn are compared with the angular distributions of deuterons from the (p,$\bar{d}$) reaction. The (cp,$\bar{d}$) distribution is found to peak at a larger angle than the (p,d) distribution. Spectral shapes are calculated and compared to experimental spectral shapes. (Diss. Abstr.)

10921 A STUDY OF THE PHOTONEUTRON REACTIONS IN ^{16}O. Khan, Tasneem Aijaz. Ontario, Can.; Univ. of Toronto (1968).

Thesis.

Photoneutron spectra from ^{16}O were obtained at bremsstrahlung end point energies of 33 MeV and in one MeV steps from 27 to 22 MeV by the time-of-flight technique. By comparing the ^{16}O yields to yields obtained from deuterium, the photoneutron spectra were converted to $^{16}O(\gamma,n)^{15}O$ cross sections for transitions to the ground and excited states of ^{15}O. Hence branching ratios to the various states of ^{15}O were derived. Significant branching to the 2 hole, 1 particle states of ^{15}O is apparent. The implications of the present results for the theories of the nuclear photoeffect are considered and it is concluded that although theories using 2 particle, 2 hole configurations are necessary, they are not sufficient to explain all of the intermediate structure in the giant resonance. (Diss. Abstr.)

10922 ^{12}C AS A THREE-ALPHA NUCLEUS. Hutzelmeyer, Hannes R. Tallahassee; Florida State Univ. (1968). 155p.

Thesis.

The ^{12}C nucleus is treated as a three-alpha system, its low-lying states with isobaric spin T = 0 are calculated. The fully antisymmetrised wave functions diagonalise a realistic Hamiltonian with soft-core nucleon-nucleon potentials. The wave functions consist of superpositions of cluster wave functions. All radial dependencies are expressed in terms of Gaussians, so that all appearing integrals can be evaluated in a closed form. The inclusion of a short-

range correlation between nucleons is taken care of approximately. The actual calculation is performed by means of a FORTRAN program on CDC computers. A short survey is given on experimental facts and nuclear models referring to ^{12}C. The computed numbers are compared with experimental energy values. Both positive and negative parity states appear in correct order. The agreement is quite reasonable, deviations can be explained. The importance of clustering and the strong influence of the Pauli principle is shown, especially for the $J^\pi = 0^+$ level at 7.65 MeV and for the first two negative parity states 3^-(9.63) and 1^-(10.84). (Diss. Abstr.)

10923 INTERFERENCE BETWEEN COMPOUND-NUCLEUS AND DIRECT MECHANISMS IN THE $^{12}C(d,p)^{13}C$ NUCLEAR REACTION. Leonard, James Walton. Eugene, Oreg.; Univ. of Oregon (1968). 111p.

Thesis.

Interference between compound-nucleus and direct mechanisms in nuclear reactions is not yet understood. To learn more about this interference in reactions that show features of both processes, the $^{12}C(d,p)^{13}C$ reaction was studied in the region near 3.4 MeV. Seven angular distributions and an excitation function were taken in the energy range 3.3 to 3.7 MeV. Incident deuterons from the Van de Graaff accelerator were used to bombard a selfsupporting carbon target. Outgoing proton spectra were measured using two solid-state detectors mounted 180 degrees apart. The first part of the data were obtained using lithium drifted silicon detectors made by the author. After nine months of use, these detectors were replaced by two surface barrier detectors needed for another experiment, and the remainder of the data were taken with the later detectors. The spectra were collected and processed using PDP-7 and IBM 360/50 computers. The data were compared with calculated differential cross sections and excitation functions. For this purpose a FORTRAN distorted wave Born approximation program was modified to allow addition of an isolated compound-nucleus resonance term to the direct reaction amplitudes with the relative phase being an adjustable parameter. The optical-model parameters for the direct part, assumed to be constant in the energy region considered, were determined by using a known extrapolation formula for the proton channel and by fitting the off resonance angular distribution at 3.69 MeV for the deuteron channel. The resonance parameters and the relative phase were adjusted until agreement was reached between the calculated and experimental angular distributions. It was found that the energy dependence of the experimental cross sections at 25 and 140° could be fit fairly well with a nonzero, but constant, relative phase parameter. The total width of the level extracted from the calculation was narrower than that found by other workers for $^{12}C-(d,p_0)$, but it agreed with the value obtained by others from pure compound nucleus reactions going through the same state in the compound nucleus. (Diss. Abstr.)

10924 LEVELS IN ^{15}N RESULTING FROM PROTON CAPTURE OF ^{14}C. Siefken, Hugh Edward. Lawrence, Kan.; Univ. of Kansas (1969). 100p.

Thesis.

The $^{14}C(p,\gamma)^{15}N$ reaction was used to study states in ^{15}N up to 10.81 MeV excitation. Decay schemes and branching ratios were determined for these levels and resonance strengths were measured for three of the four resonances investigated. Several new gamma ray transitions were found which permitted the study of lower excited states by angular distribution and triple correlation measurements. The existence of a second state at 9.16 MeV is confirmed and its spin determined to be $J = 5/2$. The spin of the 8.31-MeV state is found to be $J = 1/2$. The spins of nine other states were confirmed. Multipole mixing parameters for most of the gamma rays observed were determined and when possible, compared with values obtained from earlier measurements. (Diss. Abstr.)

10925 STUDY OF THE GIANT DIPOLE STATES IN SOME LIGHT NUCLEI. Wu, Chung-Pao. New Haven; Yale Univ. (1968). 178p.

Thesis.

The energy spectra of photoneutrons from the reactions $^{12}C(\gamma,n)^{11}C$, $^{13}O(\gamma,n)^{12}O$, $^{24}Mg(\gamma,n)^{23}Mg$, $^{28}Si(\gamma,n)^{27}Si$ and $^{32}S(\gamma,n)^{31}S$ were measured using an electron linear accelerator and associated nanosecond time-of-flight neutron spectrometer. Differential cross sections at 90°, for ground state transitions, were determined relative to the deuterium photoneutron cross section. In ^{12}C and ^{16}O, accurate cross sections are obtained using CD_2-CH_2 and D_2O-H_2O difference measurements. Detailed comparisons between the present results and published (γ,p_0) results were made in order to obtain information on the energy dependence of isospin mixing in the giant dipole states and on the question of resonances versus statistical fluctuations. It is concluded: (i) in ^{12}C, there is significant isospin mixing throughout the giant resonance region; (ii) in ^{16}O, the dipole states have a high degree of isospin purity; (iii) in ^{32}S, correlations are observed in the energies of states indicating that the cross section represents resonances and not fluctuations. In ^{28}Si there is evidence in favor of fluctuations and in ^{24}Mg no definite conclusion can be drawn from the present work. (Diss. Abstr.)

10926 HARTREE-FOCK DESCRIPTIONS OF EXCITED STATES IN ^{16}O? Afnan, I. R.; Clement, David M.; True, William W. (Univ. of California, Davis). Phys. Rev.; 185: 1231-2 (20 Sep 1969).

Evidence is presented to indicate that the low-lying states of ^{16}O cannot be represented by a Hartree-Fock determinant when "realistic" forces are used in the Hartree-Fock calculation. (auth)

10927 DECAY OF THE 6.18-MeV $J^\pi = 0^+$ LEVEL OF ^{10}Be. Alburger, D. E. (Brookhaven National Lab., Upton, N. Y.); Warburton, E. K.; Gallmann, A.; Wilkinson, D. H. Phys. Rev.; 185: 1242-50(20 Sep 1969).

The reaction $^9Be(d,p)^{10}Be$ (at $E_d = 3.25$ MeV) was used to investigate the decay of the 6.18-MeV $J^\pi = 0^+$ level of ^{10}Be. Both of the γ-ray transitions 6.18 → 5.96 and 6.18 → 3.37 were observed by means of $\gamma-\gamma$ coincidence experiments using Ge(Li) and NaI(Tl) detectors. The mean life of the 6.18-MeV state is found to be $1.1^{+0.3}_{-0.4}$ psec from a Doppler-shift measurement on the 6.18 → 5.96 transition. It is concluded that the 6.18 → 5.96 transition takes place mainly to the $J^\pi = 1^-$ component of the $J^\pi = (1^-,2^+)$ 5.96-MeV doublet and has an energy of 219.4 ± 0.3 keV. The intensities of proton groups leading to levels of ^{10}Be in the (d,p) reaction at $E_d = 3.25$ MeV were determined with a Buechner spectrograph. By combining the present results with previous measurements on the 6.18-MeV E0 ground-state transition, the branching ratios (in %) from the 6.18-MeV state to the states at 5.96 MeV ($J^\pi = 1^-$), 3.37 MeV ($J^\pi = 2^+$), and 0 MeV ($J^\pi = 0^+$) are found to be 4.6 ± 1.5, 95 ± 2, and 0.24 ± 0.08, respectively. The significance of these results is discussed. Incidental results are a value of 169.25 ± 0.04 keV for the ^{13}C 3.85 → 3.68 transition and a meanlife of 2.0 ± 0.6 psec for the ^{10}B 2.15-MeV level. (auth)

10928 CONFIGURATION MIXING OF MAJOR SHELLS IN MASS-16 AND MASS-17 NUCLEI. Bobker, J. (Polytechnic Inst., Brooklyn). Phys. Rev.; 185: 1294-1302(20 Sep 1969).

The odd-parity ($T = 1/2$) levels of ^{17}O are investigated within the framework of the spherical shell model in order to determine the importance of configuration mixing of the (2s, 1d) and 1p major shells. Particles in the $2s_{1/2}$ and $1d_{5/2}$ subshells and holes in the $1p_{1/2}$ subshell are considered. It is shown that a configuration space which includes both 2-particle-1-hole states and 4-particle-3-hole states is required to achieve good agreement between calculated and experimental energies in the range of excitation from 3.06 to 8.88 MeV. As confirmed by previous work, calculations based on a truncated 2-particle-1-hole space predict excitation energies that are higher by about 2 MeV than the observed values. In addition, the effects of $(2s_{1/2}, 1d_{5/2})$-$1p_{1/2}$ mixing on the odd- and even-parity ($T = 1$) states of ^{16}N above its four lowest levels are evaluated. The consequences of this mixing are a lowering of calculated energies by an average of 2-3 MeV and many changes in the predicted sequence of levels. The significance of these results in relation to the neutron elastic scattering cross section for ^{15}N is discussed, and a need for more experimental data on the spins and parities of ^{16}N levels is indicated. (auth)

10929 DISTORTED-WAVE ANALYSIS OF THE $^{11}B(d,p)$ REACTION LEADING TO THE LOWEST UNBOUND LEVEL IN ^{12}B. Fortune, H. T.; Vincent, C. M. (Argonne National Lab., Ill.). Phys. Rev.; 185: 1401-3(20 Sep 1969).

The 3.39-MeV state of ^{12}B is 20 keV above the threshold for neutron decay, and has been seen both in $^{11}B(d,p)^{12}B$ and in $^{11}B(n,n)^{11}B$. An analysis of $^{11}B(d,p)^{12}B$ by a new technique is presented and the stripping and elastic scattering data are combined to obtain the spin and parity of the state in question. (auth)

10930 DIRECT TWO-NUCLEON PICKUP IN (d,α) REACTIONS. Curry, J. R.; Coker, W. R.; Riley, P. J. (Univ. of Texas, Austin). Phys. Rev.; 185: 1416-28(20 Sep 1969).

Angular distributions for the (d,α) reactions on ^{12}C, ^{14}N, and ^{31}P targets were measured in the 10 to 12-MeV incident-deuteron energy range. The $^{31}P(d,\alpha)^{29}Si$ measurements were repeated at a deuteron energy of 33.7 MeV. The experimental angular distributions for the first three α groups in each reaction were fitted and analyzed using a zero-range distorted-wave Born-approximation two-particle pickup calculation. Nuclear-structure factors were computed from shell-model wave functions and tested against the experimental results. The shapes of the angular distributions and the relative magnitudes of the experimental cross sections are both found to be successfully predicted by the theory. The ground-

state reactions also were analyzed using a simple cluster-transfer approximation, and the results are compared with the more exact analysis. The cluster-transfer approximation is shown to predict correctly the dominant L, J values contributing to the (d,α) reactions, but cannot give absolute cross sections. (auth)

10931 DIRECT PHOTODISINTEGRATION OF ^{9}Be IN THE LOW AND SUB-GIANT RESONANCE ENERGY REGION. Aurdal, Terje (Univ., Tuebingen, Ger.). Z. Naturforsch., 24a: 1188-95 (Aug. 1969).

Photodisintegration cross sections for the reaction $^{9}Be(\gamma,n)^{8}Be$ with photoenergies varied from threshold to about 17 MeV are calculated. The nuclear model is a single-particle shell model where the valence neutron outside the ^{8}Be core is in a spherical field. The core state is assumed to be a mixture of the ground (0^+) and the first excited (2^+) state of the ^{8}Be nucleus. The total cross sections are split according to the different contributing reaction channels. The radial wave functions in initial as well as final states are of the Saxon-Woods type. (auth)

10932 THE ^{3}(He,t) REACTIONS ON ^{7}Li AND ^{9}Be FROM 2.0 TO 4.2 MeV. Orihara, H. (Tohoku Univ., Sendai); Nakagawa, T.; Ueno, H.; Tohei, T.; Yamaya, T.; Nakagome, Y.; Baba, M.; Morita, S. Nucl. Phys.; A139: 226-40(1969).

Angular distributions for the $^{7}Li(^{3}He,t_{0,1})^{7}Be$ and $^{9}Be(^{3}He,t_{0})^{9}B$ reactions were measured in the range $E(^{3}He) = 3.0$ to 4.0 MeV. In addition excitation curves were measured for $^{7}Li(^{3}He,\alpha_{0,2})^{6}Li$ and the reactions mentioned above over the range $E(^{3}He) = 2.0$ to 4.2 MeV. The emitted tritons were identified by means of a magnetic spectrometer and a solid-state detector. The observed angular distributions were fitted with the theoretical curves which were calculated from the cut-off Born approximation with exchange effect. The cluster reduced widths for the mass-3 particles in the mass-7 and 9 nuclei were deduced by comparing the absolute value of the angular distributions with the theoretical differential cross section for incoherently mixed "knock-on" and "heavy-particle stripping" reactions. (auth)

10933 MEASUREMENT OF THE $^{10}B(n,\alpha)$ REACTION AT $E_n = 14.4$ MeV LEADING TO STABLE AND UNSTABLE LEVELS OF ^{7}Li. Antolkovic, B.; Hudomalj, J.; Janko, B.; Paic, G.; Turk, M. (Inst. Ruder Boskovic, Zagreb). Nucl. Phys.; A139: 10-16(1969).

Spectra of alpha particles produced by neutron bombardment of an enriched ^{10}B target have been measured. The angular distribution for two distinct alpha groups in the spectra belonging to the $(n,\alpha_{0,1})$ and (n,α_{2}) transitions are presented. The cross sections obtained are 8.2 ± 2.5 mb and 9.5 ± 2.8 mb, respectively. The latter has been measured in the angular range $\theta_{c.m.} = 0°-90°$. The angular distributions have been analyzed in the framework of the direct reaction theory. (auth)

10934 NEUTRON PICKUP REACTIONS IN ^{9}Be, ^{12}C, AND ^{28}Si INDUCED BY 185 MeV PROTONS. Sundberg, O.; Kaeline, J. (Uppsala Univ.). Ark. Fys.; 39: 323-43(1969).

Studies of deuterons from pickup reactions in beryllium, carbon and silicon were performed with a magnetic spectrometer. With an incoming proton energy of 185 MeV, a total resolution (full width at half maximum) of 350 keV was achieved. In most cases it was possible to relate peaks in the energy spectra to known states in the residual nucleus. The measurements covered an angular region from 2.5 to 30° in the center-of-mass system and an excitation energy range of 0 to 30 MeV. Absolute differential cross sections and excitation energies, corresponding to levels in ^{8}Be, ^{11}C and ^{27}Si, are presented in graphs and tables. Spectroscopic factors were obtained from a distorted-wave Born approximation analysis of the angular distributions. The experiment also gives evidence for excited states in ^{27}Si previously not reported. (Sweden)

10935 THE SCATTERING OF ALPHA PARTICLES BY ^{16}O BETWEEN 18.9 AND 30 MeV. Bergman, Clark. Minneapolis; Univ. of Minnesota (1968). 129p.

Thesis.

Alpha particle scattering by ^{16}O was studied in the energy range 18.9 to 30 MeV, using Van de Graaff accelerator. The target consisted of 40 μg/cm^2 of oxygen in the form of LiOH on a 20 μg/cm^2 carbon backing. Absolute cross sections were determined with an oxygen gas target. Excitation functions were measured in 20 keV steps at eight angles over the entire energy range, using computer control of the accelerator's analyzing magnet. The center of mass angles were selected to be zeros of the legendre polynomials P_1 to P_8 for elastic scattering. Inelastic scattering to the 6.05–6.13 MeV doublet in ^{16}O was also studied. Elastic differential cross sections were measured at twenty energies between 18.9 and 23.0 MeV. Nonstatistical structure is observed in the excitation functions. The spins and parities of the resonances are tentatively assigned on the basis of the elastic excitation functions. A phase shift analysis of the differential cross sections has unambiguously identified a resonance at 21.05 MeV in ^{20}Ne($\Gamma \approx 80$ keV) to be $J^{\pi} = 9^-$. A similar resonance at 20.70 MeV in ^{20}Ne is probably 9^-. The 9^- members of the lowest two negative parity rotational bands in ^{20}Ne are expected to be near 20 MeV. (Diss. Abstr.)

10936 A STUDY ON THE ^{7}Li + p AND ^{6}Li + d NUCLEAR REACTIONS. Lee, Chul Chu (Yonsei Univ., Seoul). J. Korean Phys. Soc.; 2: 1-12(Apr 1969).

Pure ^{7}Li and ^{6}Li thin film targets were produced by a newly devised double layer coating system and were bombarded by 40 keV to 130 keV protons and deuterons giving rise to the following nuclear reactions: $^{7}Li(p,\alpha)^{4}He$ (Q = 17.337 MeV), $^{6}Li(d,\alpha)^{4}He$ (Q = 22.357 MeV), $^{6}Li(d,p\gamma)^{7}Li^{*}$, and $^{7}Li^{*} \rightarrow {}^{7}Li + \gamma(0.478\ MeV)$ (Q = 4.55 MeV). In the past the number of nuclei per cm^2 was determined by measuring the thickness of the pure lithium target in its oxidized state of LiF or Li_2SO_4 which contained impurities. The error in the measurement of the cross section was about 20–25%. In this work the new method allowed use of pure lithium and therefore made it possible to reduce the probable error to less than 10%. The following factors were also investigated: angular distributions of absolute differential cross sections; total cross section vs energy of incident particle; slopes of Gamow plot; angular distribution of produced particle energy; and energy levels of ^{7}Li. The results of this investigation are in good agreement with that of theory and the previous experimental results. (auth)

10937 POLARIZATION OF PROTONS ELASTICALLY SCATTERED ON ^{9}Be. Andreev, G. B.; Lopatko, I. D.; Borovlev, V. I.; Lutsik, V. A.; Slabospitskii, R. P.; Taranov, A. Ya. (Physical-Technical Inst., Kharkov). Yadern. Fiz.; 10: 902-6(Nov 1969). (In Russian).

Energy dependence of the polarization of protons elastically scattered by ^{9}Be nuclei in the 1 to 3 MeV region was investigated using an accelerated polarized proton beam. Investigations were performed at the scattering angle $\theta = 60°$ in l.s. The following anomalies in the behavior of the polarization were found: maximum at the proton energy 1.33 MeV, small in the absolute value but complex anomaly at the threshold of neutron emission (2.06 MeV), as well as two minima at the energies 2.48 and 2.56 MeV corresponding to the doublet of levels in the ^{10}B nucleus. (auth)

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Refer also to abstracts 9678, 9691, 10781, 10920, 10930, 10934, 10935, and 10998.

10938 (AEEW-M-933) THE THERMAL NEUTRON ABSORPTION CROSS SECTIONS, RESONANCE INTEGRALS, AND RESONANCE PARAMETERS OF SILICON AND ITS STABLE ISOTOPES. Story, J. S. (Atomic Energy Establishment, Winfrith (England)). Sep 1969. 17p. Dep. CFSTI (U. S. Sales Only). UK 3s. 0d.

The data available up to the end of November 1968 are collected and discussed. Estimates are given of the mean spacing of the energy levels of the compound nuclei near the neutron binding energy. It is concluded that the thermal neutron absorption cross section and resonance absorption integral of natural silicon are not well established. The data on these two parameters are somewhat correlated, and three different assessments of the resonance integral are presented which differ over-all by a factor of 230. Many resonances have been detected by charged particle reactions which have not yet been observed in neutron cross-section measurements. One of these resonances of ^{28}Si, at $E_n = 4 \pm 5$ keV, might account for the large resonance integral which is derived, very uncertainly, from integral data. The principal source of the measured resonance integral of ^{30}Si has not yet been located. The thermal neutron absorption cross section of ^{28}Si appears to result mainly from a negative energy resonance, possibly the resonance at $E_n = -59 \pm 5$ keV detected by the ^{28}Si (d,p) reaction. (auth) (UK)

10939 (ANU-P-457) EVIDENCE FOR INTERMEDIATE STRUCTURE IN THE COMPOUND NUCLEUS ^{24}Mg. Hellstroem, J.; Dallimore, P. J.; Davidson, W. F. (Australian National Univ., Canberra. Research School of Physical Sciences). [1969]. 7p. Dep. CFSTI (U. S. Sales Only).

Proton elastic and inelastic scattering by ^{23}Na at 8 to 12 MeV was studied for intermediate structure in the ^{24}Mg compound nucleus. The excitation functions were compared with DWBA and Hauser–Feshbach calculations. A gross structure is definitely present at this energy range and this structure has the features expected of intermediate or doorway state structure. (J.W.R.)

10940 (ANU-P-463) THE $^{41}K(p,n)^{41}Ca$ GROUND STATE REACTION FROM THRESHOLD TO 1970 keV. Din, G. U.; Lefevre, H. W. (Australian National Univ., Canberra. Research School of Physical Sciences). [1969]. 18p. Dep. CFSTI (U. S. Sales Only).

The forward neutron yield was measured with 1 keV resolution from threshold at 1237.25 ± 0.5 to 1440 keV, and with 2 keV resolution to 1970 keV. Average spacing of strongly excited 3^- levels in ^{42}Ca at an excitation of 10.3 MeV is found to be 20 keV. On the basis of intensity a group of levels near E_p = 1875 keV is proposed to be the T_z = 1, T = 2 split Coulomb analog of a 3^- state near 2390 keV in ^{42}K. (auth)

10941 (ANU-P-464) THE $^{29}Si(p,\gamma)^{30}P$ AND $^{29}Si(p,p'\gamma)^{29}Si$ REACTIONS FROM 1300 TO 1850 keV. Din, G. U. (Australian National Univ., Canberra. Research School of Physical Sciences). [1969]. 18p. Dep. CFSTI (U. S. Sales Only).

Proton capture resonances in the $^{29}Si(p,\gamma)^{30}P$ reaction and the yield of 1.27 MeV γ-rays from inelastic scattering of protons from ^{29}Si were studied in the range E_p = 700 to 1850 keV. The measurements were made using thin enriched $^{29}SiO_2$ targets on tungsten backings with a proton beam energy resolution of 1 keV. Sixteen resonances of widths between 1 and 7 keV were observed in the $^{29}Si(p,\gamma)^{30}P$ reaction and 8 resonances in the $^{29}Si(p,p'\gamma)^{29}Si$ reaction. The resonances at 1324, 1748, and 1770 keV were found to be doublets. (auth)

10942 (ANU-P-473) ANGULAR DISTRIBUTIONS OF GAMMA RAYS FOLLOWING THE $^{64}Ni(p,n\gamma)^{64}Cu$ REACTION. Davidson, W. F.; Dallimore, P. J.; Hellstroem, J. (Australian National Univ., Canberra. Research School of Physical Sciences). [1969]. 17p. Dep. CFSTI (U. S. Sales Only).

Gamma ray angular distributions in the reaction $^{64}Ni(p,n\gamma)^{64}Cu$ were measured under conditions where the incident proton energies were close to the neutron threshold for the levels of interest. Using the theoretical predictions of the compound nucleus statistical model, unique spin assignments were obtained for the 159 keV (2^+), 278 keV (2^+), and 609 keV (2^+) levels in ^{64}Cu, and the most probable spins for the other levels were found to be 344 keV (1^+), 362 keV (3^+), 663 keV (1^+), 739 keV (2^+ or 3^+), 746 keV (3^+), 878 keV (1^+ or 2^+), 895 keV (3^+) and 927 keV (1^+). Multipole mixing ratios of the γ-rays observed were also obtained. (auth)

10943 (ANU-P-475) j-DEPENDENCE OF l = 1 TRANSITIONS IN THE $^{54}Cr(d,p)^{55}Cr$ REACTION. Rosalky, D. M.; Baugh, D. J.; Nurzynski, J.; Robson, B. A. (Australian National Univ., Canberra. Research School of Physical Sciences). [1969]. 20p. Dep. CFSTI (U. S. Sales Only).

Differential cross sections for six l = 1 transitions in the reaction $^{54}Cr(d,p)^{55}Cr$ were measured at a deuteron bombarding energy of 8 MeV. The data were described qualitatively by DWBA calculations employing spin-orbit terms in the deuteron and proton optical-model potentials to reproduce the observed dependence on j. Spin assignments of $\frac{3}{2}$, $\frac{1}{2}$, $\frac{3}{2}$, $\frac{1}{2}$, and $\frac{1}{2}$ were made for the ground, 0.245, 0.573, 1.487, and 2.905 MeV states in ^{55}Cr. The $2p_{\frac{3}{2}}$ and $2p_{\frac{1}{2}}$ spectroscopic factor sums were found to be 0.66 and 0.56 respectively indicating a large admixture of $(2p_{\frac{1}{2}})^2$ configurations in the ground state of ^{54}Cr. (auth)

10944 (ANU-P-477) THE REACTION $^{23}Na(p,p)$ IN THE RANGE 8.0 TO 12.0 MeV. III. ANALYSIS OF AVERAGE INELASTIC CROSS SECTIONS, FLUCTUATIONS, AND MODEL COMPARISONS. Hellstroem, J.; Dallimore, P. J.; Davidson, W. F. (Australian National Univ., Canberra. Research School of Physical Sciences). [1969]. 33p. Dep. CFSTI (U. S. Sales Only).

Proton elastic and inelastic cross sections were measured in the range 8.0 to 12.0 MeV. The results were analyzed using both the combined optical-model, DWBA and Hauser-Feshbach theories and the theory of fluctuations. Predictions of the different models are compared and it is found that intermediate structure is interpreted differently by each model. However, after the effects due to the intermediate structure are taken into account, the agreement between the models is good. (auth)

10945 (UCRL-19375) MATHEMATICAL CONSIDERATIONS OF DETERMINING NEUTRON SPECTRA FROM ACTIVATION MEASUREMENTS. Routti, Jorma T. (California Univ., Berkeley. Lawrence Radiation Lab.). Aug 1969. Contract W-7405-eng-48. 26p. (CONF-691101-8). Dep. CFSTI.

From 2nd International Conference on Accelerator Dosimetry and Experience, Stanford, Calif.

Several techniques of high-energy neutron spectroscopy, like those using activation detectors, moderating spheres, and nuclear emulsions, require a mathematical unfolding procedure to obtain the neutron energy spectrum from a set of measured data. The general requirements for a solution method as well as tests to study how well these requirements are met are discussed. The solution method has to be able to combine the information contained in the measured data with available prior knowledge of the neutron spectrum. Otherwise complications like nonuniqueness, oscillatory and negative character of the solution, are likely to arise. The commonly used solution techniques are reviewed and their applicability to high-energy neutron spectroscopy is discussed. The resolution obtainable for the neutron spectrum, although limited by the mathematical nature of the problem, is in most cases sufficient to be useful in problems of shielding design and operational safety. (auth)

10946 (UCRL-50736) A $\sigma(n,2n)$ COMPUTER CODE FOR 14.5-MeV NEUTRONS. Gilbert, A.; Gomberg, R. (California Univ., Livermore. Lawrence Radiation Lab.). 3 Oct 1969. Contract W-7405-eng-48. 50p. Dep. CFSTI.

The statistical model is used to calculate (n,2n) cross sections. In these calculations, an attempt is made to compensate for the existence of discrete states by using "effective thresholds." (auth)

10947 ENERGY LEVELS OF ^{26}Mg STUDIED WITH THE (n,γ) REACTION. Selin, E.; Hardell, R. (Chalmers Univ. of Tech., Goteborg). Nucl. Phys.; A139: 375-84(1969).

The energies and intensities of thermal-neutron capture γ rays from ^{26}Mg have been measured with a Ge(Li) detector in pair and anticoincidence spectrometer arrangements. An internal target of enriched ^{25}Mg has been used. The reaction Q-value and excitation energies have been determined. The decay scheme of ^{26}Mg is discussed on the basis of branchings found in this investigation. (auth)

10948 NUCLEAR STRUCTURE STUDIES OF ^{87}Rb, ^{88}Sr, AND ^{89}Y USING THE INELASTIC SCATTERING OF 42-MEV alpha-PARTICLES AND THE $(d,^3He)$ REACTION ON ^{90}Zr, ^{89}Y, AND ^{88}Sr. Shreve, David Culbert. Seattle; Univ. of Washington (1968). 251p.

Thesis.

The elastic and inelastic scattering of 42-MeV α-particles from ^{87}Rb, ^{88}Sr, and ^{89}Y, and the $(d,^3He)$ reaction on ^{90}Zr, ^{89}Y, and ^{88}Sr using 21-MeV deuterons were investigated. Angular distributions were measured for inelastic scattering leading to the 0.40-, 1.43-, 1.76-, 2.01-, 2.24-, 2.40-, and 2.76-MeV states of ^{87}Rb, and 1.84-, 2.74-, and 3.21-MeV states of ^{88}Sr, and the 0.906-, 1.51-, 1.75-, 2.22-, 2.53-, 2.88-, 3.10-, 3.70-, 3.98-, and 4.17-MeV states of ^{89}Y. The states of ^{87}Rb listed above, except the 0.40-MeV state, have been hitherto unreported. For the $(d,^3He)$ reaction, angular distributions were measured for the transitions to the ground state, 0.906-, 1.51-, and 1.75-MeV states of ^{89}Y, the ground state, 1.84-, 3.21-, 3.48-, and 3.64-MeV states of ^{88}Sr, and the ground state, 0.40-, and 0.84-MeV states of ^{87}Rb. The angular distributions measured in these experiments are compared with the predictions of distorted wave Born approximation calculations. An outline of the DWBA formalism and calculations of form factors for various models of the reaction are presented. For the $(d,^3He)$ reactions, angular momentum transfers are deduced and spectroscopic factors extracted. For the inelastic scattering, parity changes in the transitions and deformation parameters are extracted using a collective model analysis. Selected angular distributions for the inelastic scattering are analyzed using shell model form factors. The spectroscopic factors and inelastic scattering transition rates are then compared with the predictions of various nuclear models and properties of the nuclear wave functions are deduced. The results of these experiments are: 1) the weak-coupling core-excitation model is found to be a poor description of any of the states of ^{87}Rb or ^{89}Y; 2) some of the states of ^{87}Rb, ^{88}Sr, and ^{89}Y can be understood in terms of rather simple shell model configurations. Notably the ground state, the 0.906-, 1.51-, and 1.75-MeV states of ^{89}Y can be understood in terms of rather simple shell model configurations. Large fractions of the 1.84- and 3.21-MeV states of ^{88}Sr can be understood in terms of simple particle-hole configurations. Configuration mixing in the ground states of ^{88}Sr and ^{90}Zr seems to be implied by the analysis. (Diss. Abstr.)

10949 STUDY OF THE REACTIONS $^{40}Ca(^3He,^3He)^{40}Ca$, $^{40}Ca(^3He,d)^{41}Sc$, AND $^{45}Sc(d,d)^{45}Sc$. Abdo, Khalil Mohamed Ibrahim. Tallahassee; Florida State Univ. (1968). 171p.

Thesis.

Angular distributions for the elastic scattering $^{40}Ca(^3He,^3He)^{40}Ca$ were measured at 10, 12, 14, 16, and 18 MeV in the angular range 25 to 170° (Lab). Yield curves for this elastic scattering were measured at 90° laboratory angle, in the energy range 13 to 17 MeV. Angular distributions for the elastic scattering $^{45}Sc(d,d)^{45}Sc$ were measured in the angular range 25 to 170° (Lab) at 12.87, 11.08, 8.98, 7.19, and 5.092 MeV deuteron energies. For the reaction $^{40}Ca(^3He,d)^{41}Sc$ angular distributions for the deuteron group leading to the ground state of ^{41}Sc were measured at 10, 14,

and 18 MeV incident energies. For the same reaction angular distributions for the first excited state deuteron group were measured at 18 MeV and 14 MeV. Optical model analyses were carried out for the reactions $^{40}Ca(^3He,^3He)$ and $^{45}Sc(d,d)$. Distorted wave Born approximation predictions were calculated for the ground and first excited states angular distributions in the reaction $^{40}Ca(^3He,d)^{41}Sc$. (Diss. Abstr.)

10950 HIGH RESOLUTION SPECTROSCOPY OF ODD-ODD Cu ISOTOPES VIA DIRECT (d,α) AND (d,p) REACTIONS. Park, Yong Sook. Pittsburgh; Univ. of Pittsburgh (1968). 173p. Thesis.

Levels of ^{66}Cu, ^{64}Cu, and ^{62}Cu were studied with 12-MeV deuterons via the $^{68,66,64}Zn(d,\alpha)$ reactions, and via the $^{65,63}Cu(d,p)$ reactions. 65 to 85 levels per nucleus were identified for $E_{ex} \leq 3$ MeV as compared to 30 to 50 levels reported in the most recent literature. $^{68,66,64}Zn(d,\alpha)$ angular distributions were obtained for transitions to the majority of all levels populated over the range $10° \leq \theta \leq 90°$ and L-values for the transitions were extracted from comparison with distorted wave Born approximation (DWBA) calculations which incorporated finite range and non-locality corrections as well as microscopic form factors. Good agreement was found between the measured and calculated angular distributions. (d,p) reactions on ^{65}Cu and ^{63}Cu targets were studied to provide an independent check on the excitation energies, unique parity assignments and J^π limits. (d,p) angular distributions were obtained over the range $8° \leq \theta \leq 50°$, and l-values and spectroscopic factors were extracted from the comparison with DWBA calculations which included finite range and non-locality corrections and spin-orbit coupling for the bound neutron. It was possible to make unique 1^+ and 3^+ assignments for a fair number of levels from the recognition of L = 0 transfers, L-mixing in (d,α) transitions and overlap between (d,α) and (d,p) J^π limits. Good agreement in J^π and E_{ex} assignments was found between the present work and existing data from (n,γ) and β-decay work for almost all levels for $E_{ex} \leq 1$ MeV. (Diss. Abstr.)

10951 EFFECTIVE N-N INTERACTION AND ELECTROMAGNETIC OPERATORS DEDUCED FROM THE TABAKIN POTENTIAL: APPLICATION TO NICKEL ISOTOPES. Alzetta, R. (Univ., Trieste, Italy); Rimini, A.; Weber, T.; Gmitro, M.; Sawicki, J. Phys. Rev.; 185: 1233-42(20 Sep 1969).

The properties of low-lying states of even and odd nickel isotopes are derived by means of the quasiparticle second-Tamm-Dancoff theories in the frame of the mixed configurations $(2p_{\frac{1}{2}}, 1f_{\frac{5}{2}}, 2p_{\frac{3}{2}}, 1g_{\frac{9}{2}})^n$. The Tabakin potential renormalized for particle-hole excitations of the core is used. The agreement between theoretical and experimental spectra is good for $^{58-60}Ni$ but becomes worse for $^{61-64}Ni$. Calculated effective electromagnetic operators are used to compute E2 and M1 transition rates, E2 and M1 static moments, and inelastic electron scattering form factors. The theory fails in the case of the E2 operator, while it is successful for the M1 operator. Spectroscopic factors for one-nucleon transfer reactions are calculated and found to be in general agreement with experiment. (auth)

10952 A = 21 NUCLEI IN THE SU_3 MODEL. Sotona, M. (Nuclear Research Inst., Rez. Czech.); Gmitro, M.; Pluhar, Z.; Trlifaj, L. Phys. Rev.; 185: 1448-58(20 Sep 1969).

The nuclear SU_3 model is used to describe the basic characteristics of nuclei with A = 21. The use of the phenomenological residual interaction (Serber-Gauss and Serber-Yukawa) gives only unsatisfactory agreement with experiment. The residual interactions derived from the Hamada-Johnston and Tabakin realistic potentials, after introducing renormalization corrections with three particles and one hole, and with two particles and two holes in the intermediate states, produce ^{21}Ne and ^{21}Na spectra in satisfactory agreement with experiment and also confirm the equivalence of these potentials. More of the electromagnetic characteristics of these nuclei are described very well by the model used. (auth)

10953 NUCLEAR STRUCTURE OF ^{43}Sc. I. ENERGY LEVELS AND DECAY SCHEMES. Walinga, J.; Manthuruthil, J. C.; Poirier, C. P. (Aerospace Research Labs., Wright-Patterson AFB, Ohio). Phys. Rev.; 185: 1439-47(20 Sep 1969).

The $^{42}Ca(p,\gamma)^{43}Sc$ reaction was studied in the range E_p = 1200 to 2060 keV in order to determine the properties of the excited states in ^{43}Sc. Approximately 100 resonances due to this reaction were identified and located in proton energy to an accuracy of ±2 keV. Singles spectra were obtained at each of the resonances at E_p = 1235, 1242, 1423, 1808, 1891, and 2037 keV using a large-volume Ge(Li) detector. These spectra were used to derive consistent γ-ray decay schemes and accurate level energies for the resonant and bound states of ^{43}Sc. A new level in ^{43}Sc at 4.455 MeV was found. In addition, new results or results significantly different from earlier reports were obtained for the decay properties of most levels below 4 MeV in ^{43}Sc. A new value of Q = 4.929 ± 0.002 MeV was obtained for the $^{42}Ca(p,\gamma)^{43}Sc$ reaction. The resonance strengths were measured relative to the known strength of the E_p = 1842-keV resonance in the $^{40}Ca(p,\gamma)^{41}Sc$ reaction. (auth)

10954 STUDY OF THE LOW-LYING LEVELS OF ^{27}Mg BY ANGULAR-CORRELATION MEASUREMENTS IN THE REACTION $^{26}Mg(d,p\gamma)^{27}Mg$. Eswaran, M. A.; Ismail, M.; Ragoowansi, N. L. (Bhabha Atomic Research Centre, Bombay). Phys. Rev.; 185: 1458-69(20 Sep 1969).

The low-lying excited states of ^{27}Mg were studied by means of proton-γ angular-correlation measurements in the reaction $^{26}Mg(d,p\gamma)^{27}Mg$, employing the method of Litherland and Ferguson. Protons were detected in a solid-state annular counter near 180° to the beam, and γ rays in a NaI(Tl) crystal at seven angles between 0 and 90°. Using an analysis procedure which is independent of any assumption regarding the reaction mechanism, spin assignments of $\frac{3}{2}$, $\frac{5}{2}$, and $\frac{5}{2}$ were made to the 0.984-, 1.69-, and 1.94-MeV levels. γ-ray branching ratios of the 1.69- and 1.94-MeV levels were determined. The multipole mixing ratios of the 1.69 → 0- and 1.94 → 0.984-MeV transitions were deduced, and the latter is in agreement with that obtained from the Nilsson model following the conjecture that 0-, 0.984-, and 1.94-MeV states form the ground-state rotational band. (auth)

10955 SELF-CONSISTENT STUDY OF NUCLEAR SHAPES. Chandra, Harish (Saha Inst. of Nuclear Physics, Calcutta). Phys. Rev.; 185: 1320-31(20 Sep 1969).

Self-consistent Hartree-Fock (HF) and Hartree-Fock-Bogolyubov (HFB) calculations were performed for the even Ti, Cr, and Fe isotopes. The residual two-body interaction is assumed to be a central potential with a Yukawa radial dependence and an exchange mixture which was adjusted to fit the low-lying shell-model states of ^{18}O and ^{18}F. It was found that the HF minima occur for prolate shapes, and hence the HFB calculations are done only for prolate deformations. The HFB calculation yields normal solutions for N = Z nuclei and spherical shapes for Z < N = 28 nuclei. The effect of pairing on the ground-state properties is also studied. The value of the mass quadrupole moment for the HFB solution is smaller than that for the HF solutions for all the nuclei under consideration. A spherical BCS calculation was performed to estimate the effect of deformation on pairing energy in the HFB calculation. The excited states for the Z < N = 28 nuclei were constructed from the spherical BCS ground-state solutions in the random-phase approximation. This gave values for the $0^+ \rightarrow 2^+$ energy separation and the B(E2) rates which are in good agreement with experiment. (auth)

10956 STUDY OF THE $^{39}K(d,t)^{38}K$ REACTION AT E_d = 23 MeV. Fortune, H. T.; Puttaswamy, N. G.; Yntema, J. L. (Argonne National Lab., Ill.). Phys. Rev.; 185: 1546-52(20 Sep 1969).

The $^{39}K(d,t)^{38}K$ reaction was utilized to study states in ^{38}K below an excitation energy of 5 MeV. Spectroscopic factors were extracted by comparing the data with distorted-wave calculations. For states for which both l = 0 and l = 2 transitions are allowed, attempts were made to extract relative admixtures. Two positive-parity states, not previously reported in neutron-pickup experiments, were observed at E_x = 3.44 and 3.99 MeV. Two weak negative-parity states were observed at E_x = 2.64 (l = 1) and 4.66 MeV (l = 3), indicating the admixture of core-excited configurations in the ground-state wave function of ^{39}K. (auth)

10957 DECAY OF 18.6-MIN ^{81g}Se AND 57.3-MIN ^{81m}Se. Zoller, W. H.; Walters, W. B. (Massachusetts Inst. of Tech., Cambridge). Phys. Rev.; 185: 1541-5(20 Sep 1969).

The γ rays following the decay of the ^{81}Se isomers were studied using Ge(Li) detectors and coincidence techniques. γ rays of 260.2, 492.4, and 767.3 keV were found to follow the β decay of ^{81m}Se and γ rays of 178.3, 275.9, 290.1, 538.2, 552.4, 566.0, 649.8, and 827.3 keV to follow the β decay of ^{81g}Se. Levels were established at 275.9, 536.1, 538.2, 566.0, 649.8, 767.3, and 828.3 keV. No evidence was observed for levels at 815 or 1146 keV nor was definite β feeding observed to known levels at 836.4, 1122, and 1203 keV. The log ft values are discussed and comparisons of the levels made with those of ^{79}Br and ^{83}Br. (auth)

10958 DECAY OF 13.2-h ^{87m}Y, 80.3-h ^{87g}Y, AND 2.83-h ^{87m}Sr. Zooler, W. H.; Walters, W. B.; Coryell, C. D. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-905. Phys. Rev., 185: 1537-41(20 Sep 1969).

The decays of ^{87m}Sr and the isomers of ^{87}Y were investigated using Ge(Li) and Si(Li) γ- and x-ray detectors and a Si(Li) electron and positron detector. Half-lives of 13.2 ± 0.2, 80.3 ± 0.3, and 2.83 ± 0.05 h were determined for ^{87m}Y, ^{87g}Y, and ^{87m}Sr, respectively. Positron branching was observed from ^{87m}Y with an

intensity of 0.75% to the ground state of ^{87}Sr, and from ^{87}Sr to ^{87m}Sr with an intensity of 0.16%. The maximum β^+ energy in the decay of ^{87m}Y was determined to be 1150 ± 40 keV. The electron-capture branch from ^{87m}Sr to ^{87}Rb was measured as 0.30 ± 0.08%. Logft values were computed and β-decay hindrances discussed. The systematic variations in M4 half-lives are also discussed. (auth)

10959 ANALYSES OF QUASIELASTIC AND QUASI-INELASTIC (^{3}He,t) SCATTERING FROM THE Ni ISOTOPES. Kunz, P. D.; Rost, E.; Johnson, R. R.; Jones, G. D.; Hayakawa, S. I. (Univ. of Colorado, Boulder). Phys. Rev.; 185: 1528-36(20 Sep 1969).

Differential cross sections for 37.5-MeV (^{3}He,t) data have been measured for the Ni isotopes. The data are analyzed using a coupled-channels formalism with both macroscopic and microscopic models for the interaction. The distorted-wave Born approximation, however, is found to be a reasonable approximation. The quasielastic scattering (i.e., excitation of the state in Cu which is the analog of the Ni target ground state) is adequately explained by either model and yields the expected N − Z isotopic dependence. A macroscopic description of the quasi-inelastic scattering (i.e., excitation of the 2^+ analog state) requires a large charge-exchange deformation parameter, in disagreement with results obtained at lower energies for ^{48}Ti. A microscopic description, on the other hand, yields an extracted well depth which is roughly the same for quasielastic and quasi-inelastic scattering. The relative amounts of f and p configuration in the neutron excess are estimated using the microscopic model and are found to be consistent with shell-model calculations. (auth)

10960 LOW-LYING LEVELS OF ^{35}Cl AND ^{37}Cl. Duncan, D. D.; Buerger, K. H.; Place, R. L.; Kern, B. D. (Univ. of Kentucky, Lexington). Phys. Rev.; 185: 1515-27(20 Sep 1969).

γ-ray energies and branching ratios for the first six excited levels of ^{35}Cl and the first three levels of ^{37}Cl were measured. Proton−γ-ray coincidence techniques were used to obtain p-p′-γ correlations by means of the ^{35}Cl(p,p′γ)^{35}Cl and ^{37}Cl(p,p′γ)^{37}Cl reactions, with the inelastically scattered protons being detected at approximately 180° with respect to the beam axis. Analysis of the p-p′-γ correlations placed limits on the spins and the electromagnetic multipole mixing ratios. The attenuated-Doppler-shift method was used to determine nuclear lifetimes for the first five excited levels of ^{35}Cl and the first two excited levels of ^{37}Cl. All available data were summarized and used in calculating radiative widths and multipole strengths. (auth)

10961 STUDY OF NUCLEAR STATES IN ^{60}Ni BY INELASTIC ELECTRON SCATTERING. Torizuka, Y.; Kojima, Y.; Oyamada, M.; Nakahara, K.; Sugiyama, K.; Terasawa, T.; Itoh, K.; Yamaguchi, A.; Kimura, M. (Tohoku Univ., Sendai). Phys. Rev.; 185: 1499-1507(20 Sep 1969).

Inelastic scattering of electrons from ^{60}Ni was studied with an over-all energy resolution of 0.1% by the use of 183- and 250-MeV electron beams from the Tohoku 300-MeV linear accelerator. Peaks were found at 1.33 (2^+), 2.16 (2^+), 2.50 (4^+), 3.13 (4^+), 3.67 (4^+), 4.04 (3^-), 4.85 (2^+,4^+), 5.05 (4^+, 6^+), 6.20 (3^-), 6.85 (2^+, 5^-), and 7.05 MeV (3^-). The data were analyzed in Born approximation, using the Helm model to determine multipolarities and reduced transition probabilities. Distorted-wave calculations were also carried out for the 1.33-, 2.50-, and 4.04-MeV states. A striking feature of the present study is the discovery of the collective (G = 11) 6^+ state at 5.05 MeV. The energies and transition probabilities of low-lying states were compared with the predictions of a recently developed theory based on the shell model. (auth)

10962 DECAY SCHEME OF ^{29}Mg. Alburger, D. E.; Harris, W. R. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev.: 185: 1495-9(20 Sep 1969).

The 21.3-h half-life β-ray emitter ^{29}Mg was produced in the ^{26}Mg(t,p)^{28}Mg reaction and the subsequent γ radiations were studied with Ge(Li) and NaI(Tl) detectors. Strong γ rays with measured energies of 400.6 ± 0.2, 941.7 ± 0.4, and 1342.2 ± 0.2 keV were found to be in coincidence with the 30.6-keV γ rays from the ^{29}Al first excited state, in agreement with earlier results. Four additional weak γ rays detected in ^{29}Mg decay include a γ-ray energy of 1589.4 ± 0.4 keV in coincidence with the 30.6-keV γ ray, a γ-ray energy of 648.1 ± 0.5 keV in coincidence with the 941.7-keV γ ray, and two ground-state γ-ray transitions having energies of 1620.0 ± 0.4 and 1372.8 ± 0.2 keV. In the proposed level scheme, ^{29}Mg decays with a 95 ± 1% β-ray branch (logft = 4.49 ± 0.03) to the $J^\pi = 1^+$ 1372.8 ± 0.2-keV level of ^{29}Al, and with a 5 ± 1% β-ray branch (logft = 4.59 ± 0.08) to a 1620.0 ± 0.4-keV level which is assigned a spin parity of $J^\pi = 1^+$. (auth)

10963 ELECTRIC DIPOLE DECAYS OF 3_1^- OCTUPOLE STATES. Horoshko, R. N.; Scott, H. L.; Van Patter, D. M. (Franklin Inst., Swarthmore, Pa.). Phys. Rev.: 185: 1470-5 (20 Sep 1969).

The γ-ray decay modes of the octupole 3_1^- state were determined for ^{42}Ca, ^{48}Ti, ^{60}Ni, and ^{66}Zn from measurements of (p, p′γ) spectra using a coincidence-anticoincidence Ge(Li)−NaI(Tl) spectrometer. Available information for ^{46}Ti, ^{62}Ni, ^{70}Ge, and ^{72}Ge is also summarized. A large variation in the ratio of reduced E1 transition probabilities, R = B(E1: $3_1^- \rightarrow 2_1^+$)/B(E1: $3_1^- \rightarrow 2_1^+$), was observed. The experimental value R ≤ 0.5 for ^{48}Ti is much lower than the shell-model estimate (R = ∞) due to Soga, which assumed a pure $(f_{\frac{7}{2}})^8$ configuration and characterized the 2_1^+, 2_2^+, and 3_1^- states according to their isospin properties. This result seems to require a substantial isovector component in the 3_1^- state of ^{48}Ti. Comparisons are also made with Leper's estimate for the B(E1: 3 → 2) value based on a vibrational model, as well as with the predictions of Soga, using perturbation theory to estimate isovector components in the 2_1^+ and 2_2^+ states. (auth)

10964 POLARIZATION IN THE ^{89}Y(p,p)^{89}Y REACTION NEAR THE $d_{\frac{5}{2}}$ ISOBARIC SPIN DOUBLET. Michelman, L. S. (Univ. of Texas, Austin; Bonner, T. I.; Bernstein, E. M.; Adams, J. L.; Chen, Cary. Phys. Rev.; 185: 1485-94(20 Sep 1969).

The polarization of protons elastically scattered from ^{89}Y was observed at a laboratory angle of 125° in the incident energy range 7.1 to 7.6-MeV. Differential cross sections were also measured in this energy range at laboratory angles of 90, 125, 150, and 170°. The isobaric analogs of the 2^- and 1^- states at 2.48 and 2.63 MeV in ^{90}Y were observed at resonance energies of 7.29 and 7.46 MeV. Polarization angular distributions were taken at 7.28 and 7.45 MeV. An optical-model−plus-resonance analysis of all the data showed that these analog states could be described by a $d_{\frac{5}{2}}$ state coupling with the $\frac{1}{2}^-$ target spin. The amount of $d_{\frac{5}{2}}$ and $s_{\frac{1}{2}}$ admixture possible in the 2^- and 1^- states, respectively, was shown to be quite small. This indicates that there is very little mixing between the various 2^- and 1^- single-particle configurations in ^{90}Y. (auth)

10965 COLLECTIVE-MODEL EIGENSTATES FOR ^{25}Mg−^{25}Al. Chi, Benjamin E.; Anderson, Allen E. (State Univ. of New York, Albany). Phys. Rev.: 185: 1594-7(20 Sep 1969).

Nuclear eigenstates for the ^{25}Mg−^{25}Al mirror pair are calculated using the collective model under the assumption of strong coupling. Large deviations in the nuclear shape from axial symmetry are found to be present in these isotopes. Energy levels, static electromagnetic moments, and electromagnetic transition rates predicted by the model are compared with experiment. (auth)

10966 INVESTIGATION OF THE LOW-LYING EXCITATION STATES IN ^{25}Mg AND ^{27}Al USING DEUTERON SCATTERING. Emmerich, W.-D.; Hofmann, A.; Philipp, G. (Univ., Erlangen, Ger.). Z. Phys.; 231: 279-92(1970). (In German).

Deuteron scattering experiments were performed at the Erlangen Tandem Van de Graaff accelerator using a counter telescope with surface barrier detectors in conjunction with a PDP 7 on-line computer. Elastic and inelastic differential cross sections were obtained from deuteron scattering from ^{25}Mg and ^{27}Al at excitation energies up to 3.5 MeV. Bombarding energy was 10.1 MeV. Angular distributions and integrated cross sections are discussed using collective models. It is shown, that the levels of ^{25}Mg can be well described by the rotational model (strong coupling model). The results for ^{27}Al allow a good description by the core excitation model (weak coupling model). (auth)

10967 A STUDY OF ^{50}Sc VIA THE ^{48}Ca(α,d) REACTION. Moazed, Cyrus; Nagatani, K.; Bernstein, A. M. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Nucl. Phys.; A139: 1-9(1969).

The ^{48}Ca(α,d)^{50}Sc reaction has been studied using 31-MeV α particles with 125-keV resolution. The states below 2.5 MeV were compared to DWBA predictions of the two-nucleon transfer reaction employing the shell-model description of Kuo and Brown for ^{50}Sc. This calculation, which describes ^{50}Sc as two particles outside a ^{48}Ca core and which uses matrix elements derived from a realistic two-nucleon interaction, is also in agreement with two (^{3}He,p) experiments. The description of ^{50}Sc for levels below 2.5 MeV is good for the energies, spins and parities and two-nucleon transfer-reaction predictions. This is reasonable because the three-particle−one-hole positive-parity configurations do not play an important role until approximately 4-MeV excitation. (auth)

10968 THE LEVEL SCHEME OF ^{49}Ti AND ^{49}Ti AS STUDIED BY THE NEUTRON CAPTURE γ-RAY SPECTRA. Fettweis, P.; Saidane, M. (CEN-SCK, Mol, Belg.). Nucl. Phys.; A139: 113-31 (1969).

Using an enriched ^{47}Ti target and a natural titanium target, the neutron capture γ-ray spectrum following the ^{47}Ti(n,γ)^{48}Ti reaction has been studied by straight spectroscopy using Ge(Li) detectors;

a level scheme of ^{49}Ti has been established. Valuable information on the neutron capture γ-ray spectrum following the ^{48}Ti(n,γ)^{49}Ti reaction and on the ^{49}Ti level scheme has also been extracted from the experimental data. The neutron binding energies of ^{48}Ti and ^{49}Ti are found to be 11627.6 ± 1.3 keV and 8143.3 ± 1.2 keV, respectively. (auth)

10969 LOW-ENERGY EXCITED LEVELS OF ^{56}Fe AND ^{54}Cr. Ishidzu, T.; Kawarada, H. (Tokyo Univ.). Nucl. Phys.; A139: 132-43(1969).

The states of ^{56}Fe and ^{54}Cr are calculated by the introduction of a neutron–proton interaction. The differences between a few of the lowest energy states of singly closed shell nuclei (^{54}Fe, ^{58}Ni, etc.) and those of almost doubly closed shell nuclei (^{56}Fe, ^{54}Cr, etc.) are essentially explained by the calculation. (auth)

10970 COULOMB ENERGIES IN MASS 18 AND MASS 42 NUCLEI. Rappleyea, C. A.; Kunz, P. D. (Univ. of Colorado, Boulder). Nucl. Phys.; A139: 24-32(1969).

Coulomb energies and second energy differences in mass 18 and mass 42 nuclei are calculated for low-lying J = 0$^+$, 2$^+$, T = 1 states. The calculation was done using Kuo's "realistic" two-particle configurations and radial wave functions derived from a Woods-Saxon potential well. To a good approximation, the second energy difference is just the Coulomb interaction energy of the last two protons in ^{18}Ne and ^{42}Ti. Important effects come from inclusion of four-particle, two-hole states in the state wave functions for each triplet. Results of the calculations are found to be in close agreement with experiment. (auth)

10971 ISOMERIC CROSS-SECTION RATIOS AND TOTAL CROSS SECTIONS FOR THE ^{74}Se(n,2n)^{73g,m}Se, ^{90}Zr(n,2n)^{89g,m}Zr, AND ^{92}Mo(n,2n)^{91g,m}Mo REACTIONS. Abboud, A.; Decowski, P.; Grochulski, W.; Marcinkowski, A.; Piotrowski, J.; Siwek, K.; Wilhelmi, Z. (Univ. of Warsaw. Inst. of Nuclear Research, Warsaw). Nucl. Phys.; A139: 42-56(1969).

The isomeric ratios and excitation functions were measured for the ^{74}Se(n,2n)^{73g,m}Se, ^{90}Zr(n,2n)^{89g,m}Zr, and ^{92}Mo(n,2n)^{91g,m}Mo reactions in the neutron energy range 12 to 18 MeV. The results are compared with the statistical model predictions. Calculations were performed with the use of the superconductivity model of nuclear level density for closed shell nuclei. In the case of the ^{90}Zr(n,2n)^{89g,m}Zr and ^{92}Mo(n,2n)^{91g,m}Mo reactions the calculated isomeric ratios show good agreement with experimental data, which is not true, however, for the ^{74}Se(n,2n)^{73g,m}Se reaction. To obtain agreement between the experimental and theoretical isomeric ratios for the latter reaction some changes in the decay scheme of the ^{73}Se nucleus seem to be necessary. For all the reactions investigated the calculated total cross sections do not agree with the measured ones. The disagreement may be due to the fact that no account was taken of the gamma-neutron competition. (auth)

10972 J$^\pi$ = 2$^+$ STATES AND E2 TRANSITION RATES IN ^{46}Ca. Federman, P.; Pittel, S. (Franklin Inst., Swarthmore, Pa.). Nucl. Phys.; A139: 108-12(1969).

A model recently proposed for the description of 0$^+$ states in ^{46}Ca and ^{42}Ca is used for a more complete calculation of the properties of ^{46}Ca. The model reproduces all known 2$^+$ levels and also gives good agreement with the 11 known E2 transition probabilities. A value for the sum of the neutron and proton effective charges of 1.9 is used. (auth)

10973 CROSS SECTIONS FOR RADIATIVE CAPTURE OF FAST NEUTRON IN 10 TO 350 keV ENERGY REGION. Dovbenko, A. G.; Kolesov, V. E.; Koreleva, V. P.; Tolstikov, V. A. At. Energ. (USSR); 27: 406-11(Nov 1969). (In Russian).

Measurement and calculation results of radiative capture cross sections for 10- to 350-keV neutrons for ^{63}Cu, ^{69}Ga, ^{71}Ga, ^{74}Ge, ^{80}Se, ^{87}Rb, ^{121}Sb, ^{124}Sn, ^{128}Te, ^{192}Os, ^{193}Ir are presented. The measurements were carried out on Van de Graaff accelerator with the use of ^{7}Li(p,n)^{7}Be reaction by relative activation method in annular geometry at 105° to the proton beam direction. A fission chamber with ^{235}U layer served as a neutron flux monitor. The induced activity of samples was measured with end-window β-counters. The normalization of relative values of cross-sections σ(n,γ) was realized in the overlapping neutron energy ranges according to our data obtained earlier. The calculations were carried out on the basis of the statistical theory of nuclear reactions with the help of the optical model to calculate neutron penetrations. The results of measurements and calculations are plotted in the form of graphs. (auth)

10974 PERIODS OF SOME RADIONUCLIDES. Lagoutine, F.; Legraud, J.; Le Gallic, Y. (CEN de Saclay, Gif-sur-Yvette, France). Int. J. Appl. Radiat. Isotop.; 20: 868-71(Dec 1969). (In French).

Determinations of the half-lives of ^{32}P, ^{35}S, ^{110m}Ag, ^{170}Tm and ^{199}Au are reported, for which nuclides various values are reported in the literature. Values obtained were ^{32}P = 14.268 ± 0.042 days; ^{35}S = 87.48 ± 0.40 days; ^{110m}Ag = 250.38 ± 0.90 days; ^{170}Tm = 127.10 ± 0.92 days; and ^{199}Au = 3.129 ± 0.011 days. (UK)

10975 STUDIES IN INTERNAL CONVERSION PROCESSES: α_K STANDARDS AND L-, M-, N-, AND O-SUBSHELL RATIOS. Amtey, Sharad Ramchandrarao. Nashville; Vanderbilt Univ. (1968). 139p.

Thesis.

Measurements of K-conversion coefficients and of L-, M-, N- and O-subshell ratios of E2 transitions were made in an iron-free double-focusing spectrometer. A review of experimental and theoretical M-subshell results was carried out. To serve as standards the total and K-conversion coefficients of the 834.85 ± 0.10-keV, 897.96 ± 0.10-keV and 1115.44 ± 0.10-keV transitions in ^{54}Cr, ^{85}Sr and ^{65}Cu were measured respectively. From gamma-ray and electron spectra measured with Ge(Li) and Si(Li) detectors one can obtain conversion coefficients when well measured α_k values are available for different energies to use as normalizing standards. The internal-external conversion method was used to measure the conversion coefficients of transitions in ^{54}Cr, ^{85}Sr and ^{65}Cu. ^{99m}Tc conversion coefficients for the 2.24-, 140.48- and 142.72-keV transitions were measured. A careful survey of the available experimental and theoretical M-subshell ratios in the literature up to June, 1967 was made. These results were compared with the older, unscreened calculations of Rose and the new calculations including screening by Pauli and Hager and Seltzer. Some of the more important conclusions are the following: (a) The M-subshell ratios/L-subshell ratios for the same subshells are always close to 1. (b) The experimental M_{IV+V}/M_{III} ratios are considerably lower than the theoretical ratios. (c) The unscreened M_I/M_{II} and M_I/M_{III} ratios are higher than the screened calculations of low transitions of low transition energy but these become equal and cross to become lower than the screened calculations as the transition energy increases. The M-, N-, and O-subshell measurements of some pure E2 transitions in heavy deformed nuclei were measured. The following $M_I/M_{II}/M_{III}/M_{IV+V}$ ratios of the 57.9-keV, 42.88-keV and 43.5-keV transition in ^{228}Th, ^{240}Pu and ^{234}U were measured to be 5.3 ± 1.3/107 ± 8/100/2.9 ± 1.8; 5.8 + 2.1/110 ± 8/100/-; 4.2 ± 0.8/104 ± 5/100/2.0 ± 0.8 respectively. These results are compared with the theoretical calculations of Rose, Sliv and Band, Hager and Seltzer and Pauli. L-subshell ratios of 43.5-keV E2 transition in ^{234}U were measured to be 3.66 ± 0.22/114 ± 2/100 for $L_I/L_{II}/L_{III}$. The experimental values of the L-subshell ratios agree with the theoretical calculations of Sliv and Band, Pauli, and Hager and Seltzer within the experimental errors. However, a 6% anomaly in L_I-subshell as observed in the rare-earth region cannot be excluded. (Disser. Abstr.)

10976 ELECTRON SCATTERING STUDIES ON ^{40}Ca AND ^{48}Ca. Eisenstein, Robert Alan. New Haven; Yale Univ. (1968). 138p.

Thesis.

An electron beam was used in systematic studies of the charge distributions of ^{40}Ca and ^{48}Ca. Beam energy was varied between 40 and 60 MeV, and the angular distributions include angles between 70 and 150°. Elastic electron scattering was used to extract the rms radii of the ground states, as well as a value for the difference in radii. The results indicate that this difference is not as large as that predicted by the $A^{\frac{1}{3}}$ law for nuclear radii. This finding is in agreement with other electron scattering work done at Stanford University, and the results of experiments done at Chicago on the spectra from μ-mesic atoms. Inelastic scattering experiments also were performed, yielding results for the reduced transition probability B(EL1) and the transition radius R_{tr}^2 for the following states: ^{40}Ca, 3.73 MeV (3-), 3.90 (2+), 6.94 (2+,3-); ^{48}Ca, 3.83 MeV (2+) and 4.51 MeV (3-). These results are presented and compared with those of other experiments. (Disser. Abstr.)

10977 INVESTIGATION OF THE BOHR INDEPENDENCE HYPOTHESIS FOR NUCLEAR REACTIONS IN THE CONTINUUM: α + ^{59}Co, p + ^{62}Ni; AND α + ^{56}Fe, p + ^{59}Co. Fluss, Michael Jeremiah. New York, N. Y.; Columbia Univ. (1968). 100p.

Thesis.

Measurements were made of the energy spectra at various angles of protons and alpha particles emitted from the reactions of protons with ^{62}Ni and alpha particles with ^{59}Co to determine the extent to which the de-excitation of ^{63}Cu at 20.2 MeV excitation energy is independent of its mode of formation. Similarly, ^{60}Ni at 23.6 MeV was formed by protons on ^{59}Co and alpha particles on ^{56}Fe, again to determine to what degree its de-excitation by proton and alpha-particle emission is independent of its mode of forma-

tion. Small differences in the shapes of corresponding energy spectra [(p,p') vs. (α,p), and (α,α') vs. (p,α)] that were observed in apparent violation of the Bohr-Independence-Hypothesis are removed after account was taken of the effects of angular-momentum conservation. The observed enhancement of the ratio of cross-sections $\sigma(x,p)/\sigma(x,\alpha)$ for the proton entrance-channel over that for the alpha entrance-channel cannot be interpreted in terms of angular-momentum conservation. The consequences of the possibility of isotopic-spin conservation, when considered, lead to enhanced proton re-emission similar to that observed experimentally. (Disser. Abstr.)

10978 HIGH RESOLUTION MEASUREMENTS OF GAMMA RAYS PRODUCED BY 15 MeV NEUTRONS. Joensson, B. (Lund Univ., Sweden); Nyberg, K.; Bergqvist, I. Ark. Fys.; 39: 295-311(1969).

Gamma rays produced by 15-MeV neutrons incident on natural Fe, Ni, Pb, and Bi were investigated. The measurements were performed with a high resolution lithium-drifted germanium detector. The scattering angle of the detected γ rays was within the interval 50 to 100°. Observed intensities were corrected for variation of the neutron flux in the samples multiple scattering and γ ray attenuation. Differential 80° cross sections are given for discrete γ rays relative to the cross section for the 4.43-MeV line from $^{12}C(n,n'\gamma)$. Total isotopic cross sections for inelastic scattering were estimated. (Sweden)

10979 ELASTIC PROTON SCATTERING ON ^{54}Fe. Ahlgren, Hjalmar; Idetjaern, Sven-Olof; Linusson, Hans; Maripuu, Sven; Ryfors, Jan (Chalmers Tekniska Hogskola, Goteborg). Ark. Fys.; 39: 345-53(1969).

The elastic scattering of protons on ^{54}Fe was studied for the purpose of assigning spins, parities, and proton widths for the ^{55}Co states in the proton energy ranges 1.7 to 2.0 MeV and 2.3 to 3.2 MeV. The aim was to study the strong (p,γ) resonances at 1803 keV and 1886 keV. These resonances are suggested to be isobaric analog states to the 2.058-MeV ($l_n = 1$) and 2.151-MeV ($l_n = 3$) states in ^{55}Fe. The energy resolution of the experimental set-up was, however, not sufficient to resolve these resonances which have rather small natural widths. For higher proton energies, some broad resonances with $\Gamma_p > 100$ eV were found and a few of these were analyzed. A level found at $E_x = 7765$ keV might be an analog state to the 3.032-MeV ($J^\pi = 3/2^-$ state in ^{55}Fe. (auth) (Sweden)

10980 NEUTRON DEPOLARIZATION IN ELASTIC SCATTERING AND TARGET-SPIN DEPENDENT INTERACTION. Katori, Kenji; Nagata, Tsugako (Tokyo Univ.). Tech. Rep. ISSP, (Inst. Solid State Phys.), Ser. A; No. 377, 14p(Aug 1969).

The depolarization parameter $D(\theta)$ in the elastic scattering of the 1.36-MeV neutrons was measured at $\theta_2 = 30$, 38, 80, 120 and 150° for ^{27}Al, ^{59}Co, $^{63,65}Cu$, ^{209}Bi and Ni nuclei. The departure of $D(\theta)$ from unity for the Al, Co, Cu and Bi nuclei, in contrast to the Ni one, shows that a target-spin dependent interaction undoubtedly operates in the elastic scattering process for the non-zero-spin target. (auth) (NSA of Japan)

10981 REACTION ($^3He,\alpha$) ON Ni ISOTOPES. Artemov, K. P.; Gol'dberg, V. Z.; Islamov, B. I.; Rudakov, V. P. (Inst. of Atomic Energy, Moscow). Yadern. Fiz.; 10: 911-16(Nov 1969). (In Russian).

Differential cross sections of the reaction ($^3He,\alpha$) on the isotopes $^{58,60,62,64}Ni$ are measured which correspond to the excitation of a number of levels of final nuclei. Measurements are performed at $E_{^3He} = 36$ MeV. The cross sections obtained are compared with those calculated by the distorted wave method. Ratios of spectroscopic factors for lower levels of the four Ni isotopes are close to the ratio of neutron numbers in external shells of these isotopes. (auth)

10982 QUANTUM PARAMETERS OF EXCITED STATES OF ^{69}Ga AND ^{71}Ga NUCLEI. Khodzhaev, M. M. (Inst. of Nuclear Physics, Tashkent). Yadern. Fiz.; 10: 893-901(Nov 1969). (In Russian).

Life times of the levels 320, 574, and 872 keV of ^{69}Ga and 522, 488, 1108, and 1495 keV of ^{71}Ga were measured using the βγ delayed and γγ delayed coincidence method. It is shown that the decay half-life of the above levels is $T_{1/2} \leq 0.15 \cdot 10^{-9}$ sec γγ angular correlation of the cascades 1576–320 and 1052–872 keV of the ^{69}Ga nucleus and 387–1108, 387–620, 620–488 keV of the ^{71}Ga nucleus, was investigated. General analysis of the data obtained allowed one to establish the parameters of the following levels: 320 keV—$1/2^-$ or $3/2^-$; 574 kev—$3/2^-$; 872 keV—$5/2^-$; 1893 keV—$3/2^-$ or $5/2^-$, and 1922 keV—$1/2^-$ (^{69}Ga), and 390 keV—$1/2^-$ or $3/2^-$; 488 keV—$3/2^-$; 1108 keV—$1/2^-$, and 1495 keV—$1/2^-$ (^{71}Ga). The results are discussed in terms of the de Shalit excited core model. (auth)

10983 MEASUREMENT OF MEAN MULTIPLICITY IN (n,γ) REACTIONS INDUCED BY THERMAL NEUTRONS. Kecskemeti, J.; Kiss, D. (Central Inst. of Physical Research, Budapest). Yadern. Fiz.; 10: 907-10(Nov 1969). (In Russian).

Mean multiplicity, i.e. mean number of the γ quanta, is measured on 27 elements after thermal neutron capture. The experimental results are compared with those obtained by other authors. (auth)

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Refer also to abstracts 9691, 10920, 10946, 10948, 10964, 10971, 10973–10975, 10978, 10980, 10983, 11040, 11041, and 11044.

10984 (IAE–1806) ANALYSIS OF NEUTRON FISSION OF ^{232}Th NEAR THE THRESHOLD. Vorotnikov, P. E. (Akademiya Nauk SSSR, Moscow. Institut Atomnoi Energii). 1969. 27p. (In Russian). Dep. CFSTI (U. S. Sales Only).

Results are given for the neutron fission channel of ^{232}Th near the threshold, which indicate that quasistationary states of the fissioning nuclei play an important role in the process; fission barriers for states having different K are shifted with respect to each other by a value proportional to K^2; the distribution with respect to K of states with given total moments I is nonuniform, and small values of K have greater probability. These effects permit determination from the experimental data the temperature $T = 100 \pm 50$ keV and the moments of inertia. $\hbar/2J_\perp = 2.0 \pm 0.7$ keV and $\hbar^2/2J_{||} = 6.8 \pm 1.1$ keV for the fissioning nucleus. The latter is close to the solid state value and appears to indicate that the nucleus at the fission barrier is not cold. Quasistable states also affect the probability of nonelastic scattering of neutrons. The dependence of the number of neutrons and kinetic energy of particles E_k on the excitation energy agrees with assumptions made concerning nuclear octupole deformation in the quasistable state. (auth)

10985 (KFK–986) SEARCH FOR PARITY SYMMETRY IN NUCLEAR FORCES BY MEASUREMENT OF THE GAMMA ASYMMETRY IN $^{113}Cd(n,\gamma)$. Eichler, J. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Experimentelle Kernphysik). June 1969. 71p. (In German). Dep. CFSTI (U. S. Sales Only).

Parity symmetry in nuclear forces may be investigated in the γ-decay of polarized nuclear states. If parity invariance is violated an asymmetry in γ-radiation in the direction of nuclear polarization arises. The population and orientation of nuclear states can be achieved by capture of polarized thermal neutrons in nuclei. As a test on conservation of parity in nuclear forces the asymmetry coefficient A for γ-radiation emitted after the capture of polarized thermal neutrons was measured. The reaction studied was $^{113}Cd(n,\gamma)$. Gamma energies between 8.1 and 9.4 MeV from transitions to the ground state and to neighboring excited states were studied. The result $A = (1.2 \pm 1.2)10^{-4}$ consisted with no violation of parity symmetry in nuclear forces within the accuracy of the experiment. It confirms the results obtained by Forte et al. (For 66) and Warmings et al. (War 67); it is in disagreement, however, with the asymmetry coefficient obtained by Abov et al. (Abo 68) for the same reaction. A comparison with various theoretical estimates is given. (auth)

10986 (ORNL-TM–2745) ANALYTICAL DESCRIPTION OF THE NEUTRON CROSS SECTIONS OF ^{233}U BELOW 60 eV. de Saussure, Gerard (Oak Ridge National Lab., Tenn.). Nov. 5, 1969. Contract W-7405-eng-26. 32p. Dep. CFSTI.

The neutron fission and capture cross sections of ^{233}U below 60 eV were "least-square fitted" with the Adler and Adler multilevel formalism. The physical interpretation of the resonance parameters is ambiguous because such multilevel fits on ^{233}U are not unique. The main purpose of the analysis was to provide a simple analytical description of the ^{233}U cross sections for use in calculating reactor reaction rates and in data evaluation. The fission, capture and total cross sections and the values of η obtained from the resonance parameters are compared with recent measurements of those quantities. (auth)

10987 (UCRL–18964) SPECTROSCOPIC INFORMATION FROM HEAVY-ION REACTIONS. Stephens, F. S. (California Univ., Berkeley. Lawrence Radiation Lab.). Aug 1969. Contract W-7405-eng-48. 32p. (CONF-690804–17). Dep. CFSTI.

From International Conference on Properties of Nuclear States, Montreal, Canada.

The general subject of spectroscopic studies following heavy-ion reactions is briefly outlined, followed by a more detailed evalua-

tion of the (HI,xn) reactions for such studies. This type of reaction provides a unique opportunity for the systematic study of high angular momentum states. Examples of the types of spectroscopic information obtained using (HI,xn) reactions are presented. (auth)

10988 (UCRL-18978) HIGH-RESOLUTION GAMMA AND X-RAY SPECTROSCOPY ON UNSEPARATED FISSION PRODUCTS. Wilhelmy, Jerry Barnard (California Univ., Berkeley. Lawrence Radiation Lab.). Aug 1969. Contract W-7405-eng-48. 364p. Dep. CFSTI.

Thesis.

X-ray and γ-ray studies were made on the short-lived products formed from the spontaneous fission of ^{252}Cf. The fission fragments from an ~10-μg source of ^{252}Cf (3.7×10^8 fissions/minute) were embedded in a continually-moving belt system and transported past a detection point located some 19 inches from the source. By varying the velocity of the tape, spectra were obtained for transit times ranging from 0.27 seconds to 4.8 hours. Three individual experiments were performed: (1) K x-ray, γ-ray coincidence studies, (2) high resolution γ-ray singles studies, and (3) high resolution K x-ray singles studies. In the coincidence studies it was possible to follow the decay of approximately 200 transitions and, through the x-ray energies, establish the element emitting the gamma ray for a large number of these. For the γ-ray singles studies 20,000 individual γ-ray peaks were analyzed at the various experimental transit times. From the K x-ray singles measurements it was possible to determine the quantitative K x-ray yields as a function of time for all the elements appreciably populated from the fission of ^{252}Cf (rubidium-europium). (auth)

10989 THE TOTAL CROSS SECTION OF ^{234}U AND THE PARAMETERS OF ITS SUB-THRESHOLD FISSION RESONANCES. James, G. D. (Atomic Energy Research Establishment, Harwell, Eng.); Slaughter, G. G. Nucl. Phys.; A139: 471-80(1969).

A measurement of the total cross section of ^{234}U is found to give a level spacing of 12.3 ± 1.5 eV and a neutron strength function of $(1.09 \pm 0.36) \cdot 10^{-4}$ determined from the neutron widths of 38 resonances below 687 eV. These fine structure resonances form the major part of a narrow intermediate structure resonance in the sub-threshold fission cross section of ^{234}U. Combined with the fission cross section data of James and Rae, the neutron widths enable the fission widths of the resonances to be determined. It is shown that the fission widths have a Lorentzian energy dependence superimposed on a Porter–Thomas distribution as predicted by Weigmann and Lynn and that the observed structure is most probably an example of weak coupling between states in the first and second fission potential barrier minima. (auth)

10990 STUDY OF THE ^{90}Zr(^{3}He,t) REACTION. Hayakawa, S. I.; Fadner, W. L.; Kraushaar, J. J.; Rost, E. (Univ. of Colorado, Boulder). Nucl. Phys.; A139: 465-70(1969).

Differential cross sections were measured for the ^{90}Zr(^{3}He,t)^{90}Nb reaction at 37.7 MeV. The ground state analog of ^{90}Zr and some low-lying natural parity (i.e., even J, even parity) states were adequately described by a conventional microscopic DWBA analysis with $(g_{9/2})^2_J(g_{9/2})^{-1}_n$ orbitals although the interaction strengths were found to increase with increasing J. For the unnatural parity states with T = 4 it was found that the same discrepancy between theory and experiment exists as was pointed out in the case of ^{54}Fe(^{3}He,t)^{54}Co studies, viz. the microscopic reaction model with central forces predicts that the cross section is dominated by orbital angular momentum transfer L = J − 1 while the data are better described by L = J + 1. However, good fits were obtained for the states of 1^+ at 2.12 MeV and 3^+ at 0.65 MeV by including tensor force in the effective interaction. The results indicate that the tensor force is quite important for exciting these odd-spin states. (auth)

10991 DECAY OF THE ISOMERS OF ^{102}Tc. Blachot, J.; Pinston, J. A.; Schussler, F. (CEN, Grenoble, France). Nucl. Phys.; A139: 434-50(1969). (In French).

The study of the beta and gamma activity obtained with the reaction ^{102}Ru(n,p)^{102}Tc (4.5 min) enabled the existence of five new excited levels in ^{102}Ru at 2616.4, 2702.0, 2817.9, 2813.9, and 2912.6 keV to be shown. A partial disintegration scheme is also proposed for ^{102}Tc (5s) produced by fission of ^{235}U. The relative position of the isomers is established. (auth)

10992 THE DECAY OF 67 HOUR ^{99}Mo. Cook, W. B.; Schellenberg, L.; Johns, M. W. (McMaster Univ., Hamilton, Ont.). Nucl. Phys.; A139: 277-88(1969).

NaI(Tl) and Ge(Li) detectors have been used singly and in coincidence to study the gamma rays associated with the decay of 67 h ^{99}Mo. Twenty-four of the twenty-eight observed transitions have been located by energy fit and by coincidence data, the remainder by energy fit alone. The resulting decay scheme consists of levels at 140.5 ($\frac{1}{2}^+$), 142.6 ($\frac{1}{2}^-$), 181.1 ($\frac{3}{2}^+$), 509.1 ($\frac{3}{2}^-$), 534.3, 671.5 ($\frac{5}{2}^-$), 761.6 ($\frac{5}{2}^+$), 920.5 ($\frac{3}{2}^+,\frac{1}{2}^+$), 1004.0 ($\frac{3}{2}^-$), 1072.9 ($\frac{5}{2}^-$), 1129.3 ($\frac{1}{2}^-,\frac{3}{2}^-$), 1142.0 ($\frac{3}{2}^-$), 1199 ($\frac{1}{2}^-,\frac{3}{2}^-$). (auth)

10993 THE PRIMARY CHARGE OF FISSION PRODUCTS FROM THE THERMAL NEUTRON FISSION OF ^{235}U. Sistemich, K.; Armbruster, P.; Eidens, J.; Roeckl, E. (Kernforschungsanlage, Juelich, Ger.). Nucl. Phys.; A139: 289-307 (1969).

The average primary charge Z_p of fission products from thermal neutron fission of ^{235}U is determined by measuring the number of β-decays suffered by the fission products, which are mass separated with the gas-filled mass separator of the research reactor FRJ-2. The measurement is performed with a 4π plastic detector to avoid errors caused by conversion electrons and γ-rays emitted in coincidence with β-decays. It is extended over the mass ranges $86 < A < 104$ and $137 < A < 143$ for light and heavy fission products, respectively. The results are represented by a linear relationship between Z_p and the mass A_p of the fission products before prompt neutron emission. The mean deviation of Z_p from the unchanged charge density charge amounts to +0.41 and −0.41 charge units for light and heavy fission products, respectively. The standard deviation for the primary charge distribution for all fission products with equal mass averaged over all fission product masses is estimated to be $\bar{\sigma} = 0.59 \pm 0.03$ charge units. (auth)

10994 DECAY OF ^{109}Sn AND ^{115}Te. Burmistrov, V. R.; Shilin, V. A.; Didorenko, V. A. Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat.; No. 2, 22-5(Mar-Apr 1969). (In Russian).

Gamma energies and intensities were measured for the decays of 18-min ^{109}Sn and 6 min ^{115}Te using a Ge(Li) detector. (J.W.R.)

10995 COULOMB EXCITATION EXPERIMENTS ON ^{144}Nd, ^{146}Nd, AND ^{148}Nd. Crowley, Patrick Arthur. Pittsburg; Univ. of Pittsburgh (1968). 52p.

Thesis.

Using a 42 MeV beam of ^{16}O ions the ratio of the number of inelastically scattered ions leaving the target nucleus in its first excited state, to the number of elastically scattered ions was measured at various scattering angles. Values for the reduced transition probabilities B(E2; $0^+ \rightarrow 2^+$) and the static quadrupole moments Q_2 of the first 2^+ state were determined. The B(E2; $0^+ \rightarrow 2^+$) values obtained are 0.51 ± 0.016, 0.76 ± 0.022, and 1.36 ± 0.03 $e^2 \times 10^{-48}$ cm^4, for ^{144}Nd, ^{146}Nd, and ^{148}Nd, respectively. The static quadrupole moments of the first 2^+ states of these nuclei are found to be −0.39 ± 0.21, −0.72 ± 0.20, and −1.36 ± 0.30 e × 10^{-24} cm^2, respectively. (Diss. Abstr.)

10996 TWO- AND THREE-QUASIPARTICLE STATES IN DEFORMED NUCLEI: ^{175}Lu, ^{176}Lu, ^{177}Lu, AND ^{178}Hf. Minor, Michael McLean. Tallahassee; Florida State Univ. (1968). 179p.

Thesis.

The nuclear level schemes of ^{175}Lu, ^{176}Lu, ^{177}Lu, and ^{178}Hf were studied by means of the reactions ^{176}Lu(d,t)^{175}Lu; ^{175}Lu(n,γ)^{176}Lu and ^{176}Lu(d,d'); ^{176}Lu(d,p)^{177}Lu and ^{176}Lu(n,γ)^{177}Lu; and ^{177}Hf(d,p)^{178}Hf, ^{178}Hf(d,d'), and ^{179}Hf(d,t)^{178}Hf. The deuteron induced reactions were studied at 12-MeV beam energy, using a broad-range magnetic spectrograph. Gamma rays from thermal neutron capture in both ^{175}Lu and ^{176}Lu were measured in four energy intervals using Ge(Li) and Si(Li) detectors. Twenty transitions in the energy region between 5.3 and 6.0 MeV were observed in ^{176}Lu with a Ge(Li) detector operated in conjunction with a large NaI detector as a two-quantum escape spectrometer; 56 transitions were found in ^{177}Lu in the energy region between 4.9 and 6.9 MeV. A number of previously unreported low-energy gamma rays in the energy region 20 to 1500 keV were observed in both ^{176}Lu and ^{177}Lu. Combining the results of these experiments with those previously reported in the literature resulted in detailed level schemes for ^{176}Lu, ^{177}Lu, and ^{178}Hf. Tentative two- and three-quasiparticle rotational band assignments are given for the levels observed. (Diss. Abstr.)

10997 SHORT-LIVED DELAYED NEUTRON AND PHOTONEUTRON GROUPS FROM FISSION FRAGMENTS OF ^{239}Pu IN LIGHT AND HEAVY WATER. Huizinga, Martin. Blacksburg, Va.; Virginia Polytechnic Inst. (1969). 79p.

Thesis.

A search for short-lived (20–0.002 sec) delayed neutron groups and short-lived delayed photoneutron groups was made for ^{239}Pu in D_2O. A ^{239}Pu target was placed in the center of a sphere of D_2O and a chopped neutron beam from a reactor was allowed to impinge on the target. The ^{239}Pu target was then placed in light water and the procedure was repeated. During the "chopper closed" time interval, the production rate of delayed neutrons or delayed neutrons plus photoneutrons as a function of time was stored in a timebase multichannel analyzer. The resulting decay curves were then fitted to a sum of exponentials with a linear least squares computer program. Delayed neutron groups with

half-lives shorter than 0.43 sec do not exist for ^{239}Pu. A search for photoneutron groups with half-lives between 20 and 0.002 sec provided negative results. These results are in agreement with beta-decay theory. (Diss. Abstr.)

10998 NEMETS EFFECT IN DEUTERON BREAKUP BY HEAVY NUCLEI. Fink, C. L.; Cohen, B. L.; van der Weerd, J. C.; Petty, R. J. (Univ. of Pittsburgh). Phys. Rev.: 185: 1568-76(20 Sep 1969).

Nemets et al. have suggested that deuteron breakup by heavy nuclei may be appreciably different in closed-shell nuclei from that in neighboring non-closed-shell nuclei because of differences in the diffuseness of the nuclear surface. Their experimental evidence, based on measurements at 13.6 MeV in the Ca–Ni region, was reinvestigated with a more favorable experimental arrangement. It was found that (d,pn) and (d,np) reactions are responsible for a large fraction of the events; they seem to account for most of the differences observed, so there is no good evidence for the effect in this region. However, a study with 17- and 14.5-MeV deuterons on ^{208}Pb, ^{209}Bi, ^{197}Au, and ^{195}Pt revealed a strong Nemets effect, with ^{208}Pb having a cross section 1.2 to 2.5 times larger than the others. Since a Nemets effect could not be explained if the breakup were by Coulomb forces, nuclear forces must contribute strongly. From this, it is deduced that the usual method for determining the radius at which breakup occurs is invalid. An alternative treatment based on the difference between the neutron and proton nuclear potentials is given, and it is concluded that the breakup occurs at $r \simeq 1.3\ A^{\frac{1}{3}}$ F. (auth)

10999 HALF-LIFE OF ^{107}Pd. Flynn, K. F.; Glendenin, L. E. (Argonne National Lab., Ill.). Phys. Rev.: 185: 1591-3(20 Sep 1969).

The half-life of ^{107}Pd was determined by specific-activity measurements. The observed half-life was $(6.5 \pm 0.3) \times 10^6$ yr. (auth)

11000 GIANT RESONANCE IN DEFORMED NUCLEI: PHOTONEUTRON CROSS SECTIONS FOR ^{153}Eu, ^{160}Gd, ^{165}Ho, AND ^{186}W. Berman, B. L.; Kelly, M. A.; Bramblett, R. L.; Caldwell, J. T.; Davis, H. S.; Fultz, S. C. (Univ. of California, Livermore). Phys. Rev.: 185: 1576-90(20 Sep 1969).

Photoneutron cross sections, including $\sigma[(\gamma,n) + (\gamma,pn)]$, $\sigma[(\gamma, 2n) + (\gamma,p2n)]$, and $\sigma(\gamma,3n)$, were measured for ^{153}Eu, ^{160}Gd, ^{165}Ho, and ^{186}W as a function of photon energy from 8 to 29 MeV. The photon energy resolution varied from less than 300 keV at the lowest to 400 keV at the highest energies, and the data were taken at intervals of 300 keV or less. The source of radiation was the monoenergetic photon beam obtained from the annihilation in flight of fast positrons. The partial cross sections were determined by neutron multiplicity counting, and the average neutron energies for both single- and double-photoneutron events were determined simultaneously with the cross-section data by the ring-ratio technique. Nuclear information extracted from the data includes giant-resonance parameters, integrated cross sections and their moments, nuclear symmetry energies, intrinsic quadrupole moments, and nuclear level density parameters. The data were analyzed to obtain a mean radius parameter $R_0 = 1.26 \pm 0.02$ F for these nuclei. (auth)

11001 DECAY OF ^{193}Pt. Hopke, P. K.; Naumann, R. A. (Princeton Univ., N. J.). Phys. Rev.: 185: 1565-7(20 Sep 1969).

The Q value for the electron-capture decay of ^{193}Pt was determined to be 60.8 ± 3.0 keV, from a measurement of the endpoints of the L- and M-shell capture internal bremsstrahlung. The partial half-life for L capture was found to be 620 ± 250 yr by the determination of the specific activity of a sample. (auth)

11002 LEVELS IN ^{207}Pb FROM THE ^{208}Pb(^{3}He,α)^{207}Pb REACTION AT 28 MeV. Alford, W. P. (Univ. of Rochester, N. Y.); Burke, D. G. Phys. Rev.; 185: 1560-4(20 Sep 1969).

α particles leading to states below 4.4 MeV excitation were observed in the ^{208}Pb (^{3}He,α)^{207}Pb reaction at 28 MeV. Angular distributions were measured for strong groups leading to the known single-neutron hole states. Distorted-wave Born-approximation calculations show good agreement with the shapes of the measured angular distributions, and yield relative spectroscopic factors close to those predicted by the simple shell model, except for the h^{-1} state at 3.43 MeV. Sixteen other weakly excited states are observed above an energy of 2.6 MeV. Most of these are apparently not observed in other reactions leading to ^{207}Pb excited states. (auth)

11003 GYROMAGNETIC RATIO OF THE 129-keV STATE IN ^{191}Ir. Owens, W. R.; Robinson, Berol L.; Jha, S. (Case Western Reserve Univ., Cleveland). Phys. Rev.; 185: 1555-60(20 Sep 1969).

The properties of 82.4- and 129-keV levels of ^{191}Ir were studied following electron capture in three-day ^{191}P. The mean life of the 82.4-keV state was electronically measured to be 5.5 ± 0.5 nsec; this was confirmed by the observation of a single-line Moessbauer spectrum of a corresponding width. A lower limit of 144 ± 10 psec was established for the mean life of the 129-keV level by a Moessbauer-effect experiment. The gyromagnetic ratio of the 129-keV state was determined by a perturbed angular correlation of the 410–129-keV cascade with a source of platinum-191 diffused into an iron foil; the effective magnetic field at the iridium nucleus in this sample was measured by a Mössbauer-effect observation of the nuclear Zeeman effect of the 82.4-keV transition. The gyromagnetic ratio of the 129-keV state is +0.22 ± 0.02. The observed magnetic moments of the ground state and of the 129-keV state and the magnetic dipole transition probability of the 129-keV state are inconsistent with the simple rotational model for ^{191}Ir. (auth)

11004 (t,p) Q VALUES FOR Th, U, AND Pu ISOTOPES. Britt, H. C.; Cramer, J. D. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev.; 185: 1553-4(20 Sep 1969).

A semiconductor-detector system was used to measure ground-state Q values for the (t,p) reaction on targets of ^{239}Pu, ^{240}Pu, ^{242}Pu, ^{235}U, ^{236}U, ^{238}U, and ^{232}Th. Absolute Q values are determined to an accuracy of ±20 keV, from a calibration based on known Q values, for states excited in the reactions ^{16}O(t,p)^{18}O and ^{12}C(t,p)^{14}C. The measured Q values are in good agreement with recent mass tables by Wapstra, Kurzeck, and Anisinoff. (auth)

11005 CALCULATION OF THE GIANT RESONANCE OF ^{141}Pr UNDER VARIOUS ASSUMPTIONS ON THE RESIDUAL INTERACTION. Schaefer, Klaus (Technische Hochschule, Darmstadt, Ger.). Z. Phys.; 231: 266-78(1970). (In German).

The spectrum of the giant dipole excitation has been calculated, utilizing different types of residual interactions. The surface delta interaction is compared with a residual interaction of Gaussian shape. The interaction of the giant resonance with the surface vibrations is allowed for. The giant dipole states are treated in the particle-hole framework while the surface phonons are treated within the collective model. (auth)

11006 LEVELS OF ^{118}Sn POPULATED IN THE DECAY OF ^{118}In AND ^{118}Sb ISOMERS. Hattula, J. (Univ. of Helsinki); Liukkonen, E.; Kantele, J. Z. Phys.; 231: 203-15(1970).

Gamma rays in the disintegration of 5.0 s (1^+), 8.5 s (7^-, 8^-), and 4.4 min (4^+, 5^+) ^{118}In isomers and of 3.5 min (1^+) and 5.1 h (8^-) ^{118}Sb isomers were investigated using Ge(Li) detectors and Ge(Li)–NaI(Tl) coincidence spectrometers. The decay schemes of these isomers were constructed incorporating 17 levels in the product nucleus, ^{118}Sn, at the following energies (in keV): 0 (0^+), 1229.5 (2^+), 1757.5 (0^+), 2043.1 (2^+), 2056.4 (0^+), 2280.3 (4^+), 2321.3 (5^-), 2326.4 (1^+, 2^+), 2402.7 (4^+), 2488.8 (4^+), 2496.5 (0^+), 2575.2 (7^-), 2677.3, 2733.7 (2^+), 2929.8, 2963.5 (4^+), and 3137.1 (0^+). The structure of ^{118}Sn is briefly discussed in view of results from recent quasiparticle-model calculations. (auth)

11007 DECAY SCHEME OF ^{118}In (4.45 MIN). do Amaral, L. C. M. (Pontificia Univ. Catolica, Rio de Janeiro); de Barros Leite, C. V.; Jeronymo, J. M. F.; de Pinho, A. G.; Russo, D.; de Barros, S. Z. Naturforsch., 24a: 1196-1202(Aug. 1969).

The energies and relative intensities of the γ-radiation following the decay of the 4.45 min isomer of ^{118}In were measured using a Ge(Li) detector. A total of sixteen γ-rays was observed of which six were for the first time. A decay scheme is presented and discussed; it incorporates fifteen of the observed transitions. (auth)

11008 RADIOACTIVITY OF ^{105}Cd and ^{106}In. Starke, C. L.; Phillips, E. A.; Spejewski, E. H. (Princeton Univ., N. J.). Contract AT(30-1)-2137. Nucl. Phys.; A139: 33-41(1969).

Gamma rays from the decay of ^{105}Cd and ^{106}In were investigated with a Ge(Li) detector. The half-lives were measured to be 56.0 ± 0.5 and 5.32 ± 0.05 min, respectively. Energies and intensities were measured for over 100 γ rays between 80 and 4000 keV. Some additional properties of these energies are given. (auth)

11009 ABSOLUTE TRANSITION RATES IN ^{188}Ir. Malmskog, Sven G. (Aktiebolaget Atomenergi, Studsvik, Sweden); Berg, Valter. Nucl. Phys.; A139: 17-23(1969).

Half-lives of several excited levels in ^{188}Ir have been measured using an electron–electron delayed coincidence spectrometer. Active ^{188}Pt sources were prepared from spallation products using the ISOLDE on-line mass separator facility at CERN. The following half-lives were obtained: $T_{\frac{1}{2}}$ (54.8 keV level) = 1.93 ± 0.10 nsec; $T_{\frac{1}{2}}$ (96.7 keV level) = 1.59 ± 0.12 nsec; $T_{\frac{1}{2}}$ (187.6 keV level) = 0.056 ± 0.013 nsec; $T_{\frac{1}{2}}$ (195.1 keV level) = 0.051 ± 0.010 nsec; $T_{\frac{1}{2}}$ (478.3 keV level) $\leq$ 0.15 nsec. The 54.8 keV transition was found to have an enhanced E2 transition probability indicating a collective character for this transition. (auth)

11010 THE DECAY OF ^{182}Re(13 h and 64 h) AND ^{182}Ta(115 d) TO ^{182}W. Sapyta, J. J.; Funk, E. G.; Mihelich, J. W. (Univ. of Notre Dame, Ind.). Nucl. Phys.; A139: 161-87(1969).

The decays of ^{182}Ta (115 d), ^{182}Re (64 h), and ^{182}Re (13 h) to ^{182}W have been studied. Ge(Li) detectors were used to obtain γ-ray singles spectra in the decay of these activities and to perform $\gamma-\gamma$ coincidence measurements on the ^{182}Ta decay. All of the transitions above 70 keV reported in the conversion-electron study of Harmatz et al. of ^{182}Re were observed within the limits of the resolution of our detector with the exception of the 2023.5 keV transition. Improved values of energies for the more energetic γ-rays were obtained and a number of additional γ-ray transitions have been assigned to the ^{182}Re (13 h) activity. A number of previously unreported transitions also have been assigned to the ^{182}Re (64 h) activity. Previously unreported transitions of 110.4, 1157.7 (composite), 1181, and 1223.2 keV have been assigned to the ^{182}Ta activity. Internal conversion coefficients are calculated using previously reported conversion electron intensities and the γ-ray intensities obtained in this investigation. Revised decay schemes are proposed. Branching ratios for transitions de-exciting the positive-parity states and some of the negative-parity states were calculated and comparisons made with theoretical estimates. The level structure of ^{182}W is discussed in terms of the collective model and the quasiparticle model. (auth)

11011 TERNARY FISSION OF ^{232}Th NUCLEI INDUCED BY 14-MeV NEUTRONS. Benisz, J.; Urbanski, E. (Silesian Univ., Katowice, Poland). Acta Phys. Pol.; 36: 707-8(Oct 1969).

Ternary fission of ^{232}Th nuclei induced by 14-MeV neutrons was observed. The kinetic energy of fragments and the frequency of occurence of ternary fission to binary fission were measured. (auth)

11012 ENERGY RELEASED IN FISSION. James, M. F. (Atomic Energy Establishment, Winfrith, Eng.). J. Nucl. Energy; 23: 517-36(1969).

The effective energy released in and following the fission of ^{235}U, ^{239}Pu and ^{241}Pu by thermal neutrons, and of ^{238}U by fission spectrum neutrons, is discussed. The recommended values are: ^{235}U–192.9 ± 0.5 MeV/fission, ^{238}U–193.9 ± 0.8 MeV/fission, ^{239}Pu–198.5 ± 0.8 MeV/fission, ^{241}Pu–200.3 ± 0.8 MeV/fission. These values include all contributions except from antineutrinos and very long-lived fission products. The detailed contributions are discussed, and inconsistencies in the experimental data are pointed out. The contributions to the total useful energy release in a reactor from reactions other than fission are discussed briefly, and there is a discussion of the variations in effective energy from fission with incident neutron energy. (auth) (UK)

11013 THE EMISSION OF K-X-RAYS IN SLOW NEUTRON FISSION OF ^{233}U, ^{235}U, AND ^{239}Pu. La Fleur, P. D.; Griffin, H. C. (Univ. of Michigan, Ann Arbor). Inorg. Nucl. Chem. Lett.; 5: 845-9(Oct 1969).

The work reported was undertaken to determine the feasibility of studies of slow neutron induced fission by multiparameter measurements including K- X-ray identification of atomic number. Yields of K- X-rays from light and heavy fission fragments are tabulated, including a comparison with predicted values. The good agreement with predicted values supports the hypothesis that K- X-ray emission is largely independent of details of the fission process. (UK)

11014 THE MULTIPOLARITY MIXTURE OF THE 793 keV 2^+-2^+ TRANSITION IN ^{184}W. Zupancic, M.; Vukanovic, R.; Samuelsson, L. (Uppsala Univ.). Ark. Fys.; 39: 313-22(1969).

The multipolarity of the 793-keV $2^+ \rightarrow 2^+$ transition in ^{184}W was analyzed by $\gamma-e$ and $e-e$ directional correlations and conversion measurements. Using the experimental values of Δ (E2/M1) = 18(2) and $\alpha_K = 6.1(6) \times 10^{-3}$ the mixing ratio q(E0/E2) (abs.) $\leq$0.37 was obtained and compared with theoretical predictions. (auth) (Sweden)

11015 INTERACTION PRODUCTS OF 12.5-MeV DEUTERONS WITH MOLYBDENUM AND THEIR ISOLATION POSSIBILITIES FROM WORN-OUT CYCLOTRON PARTS. Svoboda, K.; Randa, Z.; Hruby, J. (Inst. of Nuclear Research, Rez, Czech.). Isotopenpraxis; 5: 247-52(Jul 1969).

Using chemical separations and radiometric measurements medium-half-life irradiation products of molybdenum with 12.5 MeV deuterons were determined (^{90}Nb, ^{92}Nb, ^{95m}Nb, ^{95}Nb, ^{90}Nb, ^{99}Mo, ^{95m}Tc, ^{95}Tc, ^{99m}Tc) as well as thick target yields for some of them: ^{92}Nb(0.22 μCl/μAh), ^{95}Nb(0.05 μCl/μAh), ^{99}Mo(64 μCl/μAh), ^{95m}Tc(0.76 μCl/μAh), ^{95}Tc(62.5 μCl/μaH). Moreover isolation possibilities of radioactive preparations from removed worn-out molybdenum parts of the U-120 cyclotron are discussed. (auth)

11016 A NOTE ON THE SPIN OF THE 1970-keV LEVEL IN ^{134}Ba. Sud, S. P.; Shante, V. K. S.; Trehan, P. N. (Panjab Univ., Chandigarh, India). Indian J. Phys.; 43: 40-4(Jan 1969).

The directional correlation of the 802–1168 keV gamma ray cascade in the decay of ^{134}Cs to ^{134}Ba was measured by sum-peak coincidence spectrometer to check the recently proposed (Rama Mohan et al., 1967) spin assignment 3 to the 1970-keV level of ^{134}Ba. The present investigations favor a spin 4 to this level. The 802 keV gamma transition was found to be pure E2. (auth)

11017 STUDY OF α DECAY OF ^{249}Cf. Baranov, S. A.; Shatinskii, V. M.; Kulakov, V. M. (Inst. of Atomic Energy, Moscow). Yadern. Fiz.; 10: 889-92(Nov 1969). (In Russian).

The α spectrum of ^{249}Cf was studied by means of a precision magnetic α spectrograph with the double focusing of the α-particle beam at an angle $\pi\sqrt{2}$. Sixteen α-particle groups were detected. The scheme of levels of the ^{245}Cm daughter nucleus was constructed. Interpretation of levels on the basis of the Nielsson scheme allowed one to separate rotational bands with the quantum numbers $^9/_2$[734], $^7/_2$[624], $^5/_2$[622], and apparently $^7/_2$[743]. (auth)

11018 γ-RADIATION OF SOME RARE-EARTH ELEMENTS PRODUCED FROM U FISSION BY HEAVY IONS. Gritchenko, Z. G.; Makarova, T. P.; Oganesyan, Yu. Ts.; Penionzhkevich, Yu. E.; Stepanov, A. V. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 10: 929-38(Nov 1969). (In Russian).

Rare-earth isotopes with half-life periods from 1 hour up to 1 year were extracted by radiochemical methods from the ^{238}U sample exposed to the ions ^{12}C, ^{20}Ne, ^{22}Ne, and ^{40}Ar. The elements from La up to Gd were separated by means of the electromigration method. The γ spectra in the energy region 50 to 2000 keV were investigated using the semiconductor spectrometer with the Ge(Li) detector. It is shown that the independent isotope yield at fixed Z is represented by the Gaussian distribution. The position of the maximum and the width of the isotope distributions indicate that in fission of heavy nuclei the synthesis of neutron-deficient and neutron-rich nuclei is rather effective. The measured relative intensities of separate lines in the γ spectra are in agreement with published data. Quantum yields for separate lines of γ rays from isotopes ^{135}Ce, ^{145}Pr, and ^{147}Ga are calculated from the mass distribution curve for the fission products. (auth)

11019 DISTRIBUTION OF EXCITATION ENERGY BETWEEN FISSION FRAGMENTS. Blinov, M. V.; Kazarinov, N. M.; Krisyuk, I. T.; Kovalenko, S. S. Yadern. Fiz.; 10: 923-8(Nov 1969). (In Russian).

The value of the mean product $\langle\nu_l\nu_h\rangle = 1.53 \pm 0.08$ which characterizes the excitation energy distribution between fragments is determined by simultaneous detection of neutrons emitted by light (ν_l) and heavy (ν_h) fragments of ^{235}U fission. This value is compared with the value of $\langle\nu_l\nu_h\rangle$ calculated from other experimental data. The data obtained give an evidence to the existence of the effect of redistribution of excitation energy between fragments for a certain type of fission. (auth)

11020 CROSS SECTIONS AND ANGULAR DISTRIBUTIONS OF FRAGMENTS FROM FISSION OF ^{238}Pu, ^{242}Pu, AND ^{241}Am BY NEUTRONS WITH ENERGIES FROM 0.45 UP TO 3.6 Mev. Fomushkin, E. F.; Gutnikova, E. K. Yadern. Fiz.; 10: 917-22 (Nov 1969). (In Russian).

Fractional fission cross sections and angular distributions of fragments from fission of ^{238}Pu, ^{242}Pu, and ^{241}Am are measured for 14 energy values from 0.45 up to 3.6 MeV on an electrostatic accelerator by means of the dielectric detector techniques. The obtained data are compared with the results of other authors. (auth)

11021 GAMMA SPECTRUM FOLLOWING NEUTRON CAPTURE IN ^{152}Eu(12.4γ) AND LEVEL SCHEME OF ^{153}Eu. Muehlbauer, Klaus (Technische Hochschule, Munich. Atomenergikommissionen Forsoegsanlaeg, Riso, Denmark). Z. Phys.; 230: 18-36(1970). (In German).

Using a source of $Eu_2^{151}O_3$ the (n,γ) spectrum of ^{152}Eu and ^{153}Eu was investigated by means of the Riso bent crystal spectrometer. A total of 57 transitions were fitted into a level scheme of ^{153}Eu. The rotational bands of the Nilsson states $^5/_2$+ [413], $^5/_2$− [532], and $^3/_2$+ [411] were found up to the spin values $^{15}/_2$, $^{13}/_2$, and $^{11}/_2$ respectively. The $^{13}/_2$ member of the $^3/_2$+ [411] band is suggested at 716.15 keV. The interpretation of these levels is confirmed by the comparison of the experimental branching ratios with theoretical predictions and by considerations concerning the spin dependent population of these levels. (auth)

11022 ANALYSIS OF THE DECAY OF ^{134}Cs BY $\gamma-\gamma$ ANGULAR CORRELATION MEASUREMENTS. Hofmann, S.; Walter, H. K.; Weitsch, A. (Technische Hochschule, Darmstadt, Ger.). Z. Phys.; 230: 37-64(1970). (In German).

$\gamma-\gamma$-angular correlation measurements with Ge(Li) detectors and NaJ(Tl) detectors provided the E2/M1 mixing ratios of the following gamma transitions: $3_1^+ \rightarrow 2_2^+$ (475.3 keV), $2_2^+ \rightarrow 2_1^+$

(563.3 keV), $4_1^+ \rightarrow 4_1^+$ (569.4 keV), $3_1^+ \rightarrow 2_1^+$ (1,039 keV). The angular correlation measurements were only consistent with spin 3 of the 1,643-keV level. The half-life of the 1,401-keV level was determined by delayed coincidence techniques to be $T_{\frac{1}{2}}$ (1,401 keV) ≦ 30 ps. (auth)

11023 MEASUREMENTS OF LIFETIME AND SPIN PRECESSION IN THE FIRST EXCITED STATES OF ^{197}Pt AND ^{197}Hg. Gerdau, E.; Rueter, D.; Braunsfurth, J. (Institut fuer Experimentalphysik, Hamburg). Z. Phys.; 230: 72-9(1970). (In German).

The magnetic moment of the 134-keV state of ^{197}Hg was measured by the differential angular correlation method. The half-life of the state was redetermined and the half-life of the 53-keV state in ^{197}Pt was determined. The results are: μ(134 keV-state in ^{197}Hg) = +0.950(65) nm; $T_{\frac{1}{2}}$(134 keV-state in ^{197}Hg) = 7.3(2) ns; $T_{\frac{1}{2}}$(53 keV-state in ^{197}Pt) = 16.5(1.5) ns. (auth)

11024 ELECTRIC QUADRUPOLE AND MAGNETIC DIPOLE MOMENTS OF THE FIRST EXCITED 2^+ STATES OF ^{186}Os AND ^{188}Os. Wagner, F.; Kucheida, D.; Kaindl, G.; Kienle, P. (Technische Hochschule, Munich). Z. Phys.; 230: 80-8(1970).

The spectroscopic quadrupole moments and the magnetic dipole moments of the lowest 2^+ states in ^{186}Os (137 keV) and ^{188}Os (155 keV) were determined by Moessbauer transmission experiments. The electric quadrupole moments Q_{2+}(Os 186) = − (1.80 ± 0.22) b and Q_{2+}(Os 188) = − (1.81 ± 0.24) b as well as their ratio Q_{2+}(Os 188)/Q_{2+}(Os 186) = 1.00 ± 0.07 within the limits of error agree with B(E2) data, if a comparison on the basis of the rotational model is made. For the g-factors and their ratio g_{2+}(Os 186) = 0.281 ± 0.008, g_{2+}(Os 188) = 0.305 ± 0.015 and g_{2+}(Os 188)/g_{2+}(Os 186) = 1.08 ± 0.05 was obtained. All results are compared with recent model calculations. (auth)

11025 INTERNAL CONVERSION COEFFICIENTS FOR LOW-ENERGY TRANSITIONS IN THE DECAY OF ^{132}I → ^{132}Xe. Henck, Roland; Gizon, Andree (Centre de Recherches Nucleaires, Strasbourg. Compt. Rend., Ser. B.; 269: 337-40(25 Aug 1969). (In French).

A determination is made of α_K for transitions of 136.7, 147.0, 183.2, 254.5, 262.4, 284.8, 620.8, 667.8, 772.8, 809.7, and 812.3 keV by the measurement of the respective intensities I_{eK} and I_γ and by normalization of the 667.8-keV pure E2 transition. (tr-auth)

Nuclear Theory

Refer also to abstracts 9594, 10697, 10730, 10787, 10789, 10799, 10917, 10952, 10955, 10977, and 10985.

11026 (CERN-69-30) HADRON-NUCLEUS FORWARD DISPERSION RELATIONS. Ericson, T. E. O.; Locher, M. P. (European Organization for Nuclear Research, Geneva (Switzerland)). Nov 1969. 63p. Dep. CFSTI (U. S. Sales Only).

Forward elastic scattering of pions and nucleons from complex nuclei is investigated by dispersion relations (FDR). Explicit applications cover πD, π^4He, π^9Be, π^{12}C, n^{4}He, and n^{12}C. Partly unpublished numerical evaluations are given. Results are expected to be typical for a wide range of nuclei. The unphysical region for π scattering on I = 0 nuclei is unimportant. For ^{9}Be, an effective π-nuclear coupling constant $(f^2)_{eff} \approx 0.06$ is determined. With simple assumptions, general sum rules give universally $(f^2)_{eff} = f^2_{nucleon}$ as well as small unphysical contributions to the isospin-independent amplitude. Important exchange contributions from exchange diagrams (poles and cuts) are shown to appear in nucleon scattering at lower energies. This is shown to be consistent with single particle potential scattering (optical model). The phenomenological potential scattering background term in slow neutron scattering is largely due to such exchange contributions. Antiparticle cross sections are shown to give small effects in low-energy nucleon scattering. A nonrelativistic approximation to the relativistic FDR is compared to FDR for potential scattering and the Born term is empirically determined for n^{4}He. Good agreement is obtained by comparison with the empirical potential for differential n^{4}He scattering at low energy. A self-contained elementary discussion and review of FDR is given. The relation between asymptotic wave functions and pole residues is discussed in detail. Particular attention is drawn to the importance of an exponential dependence of residues on binding and radius, and it is illustrated by simple models. (auth)

11027 (LAL-1223) EQUIVALENCE OF LOCAL AND NON-LOCAL POTENTIALS AND THE PEREY EFFECT. de Forest, Taber Jr. (Paris Univ., Orsay (France). Laboratoire de l'Accelerateur Lineaire). Oct 1969. 19p. Dep. CFSTI (U. S. Sales Only).

A general discussion of the Perey effect which relates the wave functions in equivalent non-local and energy-dependent local potentials is presented. In general this relation is non-local, $\phi_{nl} = \hat{P}\phi_L$; however it is shown that $\hat{P}$ must contain a local part $P_0 = (1 - \partial V_L(E)/\partial E)^{\frac{1}{2}}$. For reasonable potentials P_0 is expected to be the most important contribution to $\hat{P}$. Typically this produces a 15 to 20% reduction in the wave function within the nucleus for nuclear scattering. This is also shown explicitly by generating by means of an expansion an equivalent non-local potential from a given local potential. If the non-local potential is assumed to have the realistic form $V_{nl}(|\underline{r} - \underline{r}'|, |\underline{r} + \underline{r}'|)$ this allows one to determine $\hat{P}$ (beyond the first approximation, $\hat{P} \sim P_0$) and thus obtain realistic wave functions directly from those used in the usual optical model analysis of the scattering. Finally this expansion when applied in reverse provides an extension of the effective mass approximation. (auth)

11028 NON-STATIC ONE-BOSON-EXCHANGE POTENTIAL FOR NUCLEAR STRUCTURE CALCULATIONS. Erkelenz, K.; Holinde, K.; Bleuler, K. (Univ., Bonn). Nucl. Phys.; A139: 308-28(1969).

A momentum-dependent one-boson-exchange nucleon−nucleon potential containing central, $\sigma_1\sigma_2$, tensor, LS and $\sigma_1 L\sigma_2 L$ terms is presented which reproduces all experimental nuclear phase shifts up to 330 MeV, the deuteron data and the effective-range parameters. Hence, it should be adequate for reliable nuclear-structure calculations. This nuclear force has been derived from the relativistic single-particle exchange amplitudes using π, η, ω, ρ, $\sigma_0(J^P = 0^+, T = 0)$ and $\delta(J^P = 0^+, T = 1)$ mesons. The appropriate pole parameters g_π^2, m_π, m_η, m_ρ and m_ω are predetermined while g_η^2, g_ω^2, $g_{\omega 0}^2$, g_ρ^2, g_ρ^2 and f_ρ^2 (g and f denote Dirac and Pauli coupling, respectively) are searched by fitting the N-N scattering and bound-state properties. Additionally, a slightly parity-dependent zero cut-off radius d (within d the potential is set equal to zero to regularize the r^{-4} terms and derivatives of δ-distribution of the potential) is taken as an adjustable parameter in the range of the nucleon Compton wavelength. The good over-all fit to the recent empirical Livermore phase-shift analysis is represented by a least-squares value of about 2.7 for 89 pieces of data. Finally, the influence of the δ-meson and the contribution of the $\sigma_1 L\sigma_2 L$ terms have been considered. (auth)

11029 INELASTIC PHOTOPION PRODUCTION WITH EXCITATION OF GIANT RESONANCE ANALOGS: APPLICATION TO ^{16}O. Kelly, Francis J. (Naval Research Lab., Washington, D. C.); McDonald, Lawrence J.; Ueberall, H. Nucl. Phys.; A139: 329-36(1969).

Using a generalized Goldhaber−Teller model of the giant multipole resonances in ^{16}O, the differential cross section for the photoproduction of positive pions near threshold leading to giant resonance spin-flip states of various multipolarities in ^{16}N was evaluated, and the corresponding pion spectra were obtained assuming monochromatic incident photons. A possible subsequent neutron emission was also considered. It was found that at forward angles of the emitted pion the spectra are dominated by the dipole resonances, but that at larger angles the quadrupole resonance appear strongly, making it possible to experimentally identify the two types of resonances. Owing to the variability of its momentum transfer, inelastic nuclear pion photoproduction is potentially as powerful for a study of analog excitations, as inelastic electron scattering has become for $\Delta T_3 = 0$ nuclear excitations. (auth)

11030 SPECTROSCOPIC FACTORS FROM ANALOGUE RESONANCES. Harney, H. L. (Max-Planck-Institut fuer Kernphysik, Heidelberg); Weidenmueller, Hans A. Nucl. Phys.; A139: 241-68(1969).

Three methods for the determination of spectroscopic factors from data on isobaric analog resonances (IAR) are compared. It is shown numerically that, in general, all three lead to different values of the spectroscopic factor. The differences amount to as much as 50%, if the same potentials are used. The reasons for these differences are exhibited, and their physical origin is discussed. It turns out that the discrepancies arise from (i) the treatment of internal mixing, (ii) the statistical assumptions, which are introduced in order to perform the averaging over the fine structure of the IAR, (iii) the treatment of a single-particle resonance which often occurs in the proton channel some MeV below the IAR. The differences could partly be resolved if the resonance mixing phase could be determined experimentally. (auth)

11031 EQUILIBRIUM DEFORMATIONS OF NEUTRON-RICH NUCLEI IN THE A ~ 100 REGION. Arsenev, D. A. (Radiotechnical Inst., Moscow); Sobiczewski, A.; Solovev, V. G. Nucl. Phys.; A139: 269-76(1969).

Ground-state equilibrium deformations, deformation energies, and quadrupole moments are calculated for even nuclei in the 28 < Z < 50, 50 < N < 82 region. It is found that the equilibrium shapes

of these nuclei are axially symmetric. For most of them the oblate shapes are preferred. All nuclei in the investigated region seem to be soft against both beta and gamma deformations. (auth)

11032 SINGLE-PARTICLE POLES IN SHELL-MODEL REACTION THEORY. Unger, H.-J. (Moscow State Univ.). Nucl. Phys.; A139: 385-406(1969).

In the shell-model approach for nuclear reactions all possible reaction channels are divided into the group of strongly coupled and the group of weakly coupled channels. A channel is strongly coupled if it contains a single-particle pole near the real axis of the complex k-plane. In all other cases a channel is said to be weakly coupled. All physical characteristics are represented as a perturbation series with regard to the contribution of the weakly coupled channels. In zero order, (only strongly coupled channels are considered) all channel characteristics were found to be analogous to those of the R-matrix theory. In the first order, modified expressions of the familiar formulae of the shell-model approach are obtained. In the second order the continuum-continuum coupling between the weakly coupled channels is taken into consideration. It is shown that in the zero order the mean influence of the weakly coupled channels on the reaction process in the subspace of strongly coupled channels may be taken into consideration by the introduction of complex potentials in the strongly coupled channels. As a numerical example the photodisintegration of the nucleus ^{16}O is studied in the zero order of perturbation theory. (auth)

11033 CALCULATIONS WITH SEPARABLE NUCLEON–NUCLEON POTENTIALS. I. INFINITE NUCLEAR MATTER. Clement, David M.; Serduke, Franklin J. D.; Afnan, I. R. (Univ. of California, Davis). Nucl. Phys.; A139: 407-17(1969).

A number of realistic separable nucleon–nucleon interactions have been used to calculate the binding energy and saturation density of nuclear matter. The binding energy is calculated to first order in the reaction matrix using self-consistent single-particle energies for occupied states and zero potential energy for unoccupied ones. In all cases the saturation occurs at too large a density and with too much binding energy. In comparison with local potentials, all partial waves compare favorably except the ^3S which gives too large a contribution to the binding energy. The large contribution is attributed to a weak tensor force which generally leads to a strong central force in the ^3S system and thus overbinding in nuclear matter. This weak tensor force is evidenced by the small deuteron D-state probability ($P_D < 3\%$) for all of the separable potentials considered. (auth)

11034 MANY-BODY CALCULATIONS FOR NUCLEI. Koehler, H. S. (Rice Univ., Houston, Tex.). Nucl. Phys.; A139: 353-74(1969).

The structure of the reaction-matrix (K-matrix) in many-body calculations of nuclei and the origin of its nonlocality is discussed. An "effective" K-matrix interaction that is simple enough to permit extensive but exact calculations on nuclei is defined by adjusting some parameters so that nuclear matter saturates correctly, and so that the surface-energy is fitted when a self-consistent field (SCF) calculation on a semi-infinite nucleus is done. In its simplest form, neglecting structure dependent terms, this interaction is similar to a velocity dependent interaction used by Seyler and Blanchard and by Myers in Thomas Fermi calculations. SCF calculations are made with precisely the interaction used by Myers whose Thomas–Fermi calculation gave a surface energy (coefficient in the mass formula) of 18.56 MeV. The SCF calculation is found to give 21.9 MeV (±1 MeV). Qualitative differences between the SCF and Thomas–Fermi density and energy-density distributions are pointed out. While Myers and also Bethe obtain a sharp cutoff of density at the nuclear surface and a gradual increase towards the interior of the nucleus, the SCF calculations presented here give a density distribution that is symmetrical about the half-density point. It can be fitted accurately by a Fermi-distribution curve. Some preliminary results show that the above interaction gives agreement with nuclear binding energies to within 1 MeV and good agreement with nuclear radii. (auth)

11035 STUDY OF NEUTRON–PROTON CORRELATIONS IN LIGHT NUCLEI BY THE METHOD OF GENERALIZED CANONICAL TRANSFORMATION. Afanas'ev, G. N. Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat.; No. 2, 25-9(Mar-Apr 1969). (In Russian).

A nuclear Hamiltonian for the S = 0, T = 1 state is diagonalized by the unitary canonical transformation. It is shown that for N ≠ Z, the system of equations for the nucleon correlation functions have solutions only for certain phases in the correlation functions. In the case N = Z, the only solution corresponds to zero n-p correlations. (J.W.R.)

11036 THEORY OF COLLECTIVE MOTION IN MANY-BODY SYSTEMS WITH SPECIAL APPLICATION TO THE CALCULATION OF ROTATIONAL PARAMETERS OF DEFORMED NUCLEI. Wong, Shik Kam Michael. Ontario, Can.; Univ. of Toronto (1968).

Thesis.

A basic dissatisfaction with the cranking model point of view is expressed. The work of Peierls and Thouless, and Peierls and Yoccoz indicate the desirability of repeating the Nilsson and Prior calculations starting from a new vantage point which does not involve semi-classical arguments. Starting with the general formula given by Peierls and Yoccoz within the general framework of pairing force theory, an explicit expression for the moment of inertia is derived which is different from that of Belyaev and which seems to be superior to it, both in its method of derivation and in its analytical structure. The theory is applied to nuclei in the transuranic region and the results are compared with those obtained from Belyaev's formula by Nilsson and Prior. The comparison leads to a paradox: Belyaev's formula gives better agreement with experiment than does the "improved" formula. This paradox seems to arise from a set of circumstances fortuitous to the cranking model, but misleading from the point of view of understanding the theory. Indeed, the improved formula, in the absence of residual forces of any kind, also gives superficial agreement with experiment. In order to check this point in more detail, calculations were carried out in the s-d shell, using Nilsson wave functions and a residual two-body interaction of the Rosenfeld type. Again the result is the same—the cranking model gives superficially better agreement than the more exact formula. (This result is supported by independent investigations of Harvey and Das Gupta.) The conclusions are that residual interactions play a sensitive role in moment of inertia calculations and that previous calculations such as those of Nilsson and Prior must be treated with some reservations. Finally, it is shown how the general approach developed opens the door for further investigations. There is some indication that such investigations may even resolve the paradox discussed above. (Diss. Abstr.)

11037 ISOBARIC ANALOGUE RESONANCES IN PROTON ELASTIC AND INELASTIC SCATTERING. Bund, Gerhard Wilhelm. Seattle; Univ. of Washington (1968). 267p.

Thesis.

A model is presented for proton elastic and inelastic scattering at isobaric analog resonances. The basic assumption made is that the effect of compound nuclear states with isobaric spin $T_0 - 1/2$ is simulated by a phenomenological complex potential acting in the entrance and exit channels. Simple expressions for the partial widths, the total width and for the resonance displacement are obtained. The fractional parentage expansions characteristic of (d,p) stripping reactions on the parent state are explicitly introduced. In the single channel limit the results are shown to be similar to those of the coupled channel method and to those of the extended R-matrix treatment, if the assumptions of the latter theory are properly introduced. For the numerical applications surface potentials are used; the volume isospin potentials give values for the partial widths systematically too large. Preliminary analyses for the elastic partial widths for proton scattering on Sr, Mo and the isotopes of Zr and Sn were performed. Analyses in Nd, Ce, and Ba for the background cross sections, relative phases and partial widths give good agreement with experiment. The elastic and inelastic partial widths, the total width and the Coulomb displacement energy for the analog of the ground state of ^{208}Pb are studied as a function of the radius of the optical potential and partial agreement with experiment is obtained. (Diss. Abstr.)

11038 SPIN-DEPENDENT EFFECTS IN PROTON INELASTIC SCATTERING. Sherif, Helmy Sayed-Ahmed. Seattle; Univ. of Washington (1968). 210p.

Thesis.

A theoretical study is made of spin-dependent effects in inelastic proton scattering as evidenced by observables such as inelastic cross section, polarization, asymmetry, spin-flip probability, and in-plane angular correlation. Inelastic collisions considered are those leading to the excitation of collective surface modes of even target nuclei. An extension of the phenomenological optical model is made in which both spin-independent potentials contain terms linear in the nuclear collective surface coordinates. The spin-dependent part has the full Thomas form. Expressions for inelastic scattering amplitudes are derived to first order in the collective coordinates, using the distorted wave Born approximation. Despite the complexity of the derivation of the term involving the collective spin-dependent potential, it is shown that the final result is relatively simple. Expressions are given for the inelastic observables in terms of the scattering amplitudes. Symmetry properties of some of these observables in the adiabatic limit are also derived. A computer code was devised to evaluate both elastic and inelastic scattering amplitudes. The code computes elastic cross section and polarization in addition to all the inelastic observables mentioned above. A wide variety of inelastic experiments for proton energies between 16 and 155 MeV are compared with the predic-

tions of the present model. At high proton energies, data on inelastic polarization clearly require that a collective model description should contain a spin-dependent potential of the full Thomas form. In most cases analyzed, the present description appears superior to that of the distorted wave impulse approximation. In the intermediate energy region, the description of the data on inelastic asymmetry and spin-flip probability is substantially improved when the spin-dependent potential is of the full Thomas form. Similar improvements, though to a lesser degree, are observed at lower proton energies. The main conclusion is that the description of inelastic proton scattering provided by the present model is superior to that of previous models. In particular, the present analysis provides overwhelming evidence that the phenomenological spin-dependent optical potential appropriate to collective excitations has the full Thomas form. (Diss. Abstr.)

11039 NEUTRON ASYMMETRY IN POLARIZED NUCLEAR MUON CAPTURE. **Fujita, Jun-ichi (Indiana Univ., Bloomington); Fujii, Akihiko. Phys. Rev.; 185: 1475-84(20 Sep 1969).**

A general theoretical framework for neutron emissions due to nuclear muon capture is given in terms of relativistic and nonrelativistic kinematics, which can be applied to the cases where the energies of the final nuclear states belong to the continuous spectrum as well as the discrete one. The consequences of chiral invariance and conserved-vector-current (CVC) theory are taken into account in the formulation. The formulas obtained are compared with conventional ones. In particular, the pioneering work due to Primakoff is re-examined from this general framework. The difference between the CVC theory with the impulse approximation and the nuclear CVC theory is discussed. In the limit of small momentum of the emitted neutrino, the present formalism is related to the conventional β-decay formalism. The effect of nuclear collective motions on neutron asymmetry is discussed without assuming any detailed nuclear models. (auth)

11040 ANALYSIS OF THICK-TARGET RECOIL STUDIES OF HIGH-ENERGY NUCLEAR REACTIONS. **Porile, N. T. (Purdue Univ., Lafayette, Ind.). Phys. Rev.; 185: 1371-7(20 Sep 1969).**

The effect of broad velocity distributions on the vector-model analysis of average projected ranges obtained in thick-target experiments was explored. The Monte Carlo technique was used to construct laboratory velocity distributions on the basis of impact ($\nu_{||}$) and breakup (V) velocity distributions inferred from differential recoil studies. A range-velocity relation for fission products in uranium was constructed and used to convert the laboratory velocities to average projected ranges. The latter was then analyzed by means of equations based on the vector model to yield values of $\langle\nu_{||}\rangle$ and $\langle V\rangle$ which could be compared with the respective average values of the input velocity distributions. The calculation was performed for ^{99}Mo, ^{103}Pd, and ^{131}Ba formed in the high-energy fission of uranium, as well as for several simple velocity distributions. The effects tend to be rather small (0–20%), although in most cases the vector-model analysis does tend to overestimate the value of $\langle V\rangle$ and underestimate that of $\langle\nu_{||}\rangle$. (auth)

11041 MUONIC ATOMS AND THE RADIAL SHAPE OF THE NUCLEAR CHARGE DISTRIBUTION. **Ford, Kenneth W.; Wills, John G. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev.; 185: 1429-38(20 Sep 1969).**

It is found, for a rather broad set of two-, three-, and four-parameter charge-density functions, that a particular muonic-atom transition energy determines a particular moment of the nuclear charge density, $\langle r^k\rangle$. The exponent k depends on the atomic number Z and on the quantum numbers of the pair of states in question, but it depends only very weakly on the mathematical form of the charge-density function. Consequently, an almost model-independent analysis of muonic-atom energies is possible. This analysis is facilitated by introduction of the equivalent radius R_k, defined by $R_k = [\frac{1}{2}(k+3)\langle r^k\rangle]^{1/k}$. For Z = 82, a range of moments from k = 0.08 to k = 4.80 is provided by available data. The $2p_{\frac{1}{2}} \rightarrow 1s_{\frac{1}{2}}$ transition in lead, for example, measures the k = 0.80 moment and determines $R_{0.8} \cong 7.013 - 1.49\,(E - 5.788)$ F, where E is the transition energy in MeV. For this transition, as well as for several others, k is approximately a linear function of Z. (auth)

11042 A = 18 NUCLEAR REACTION MATRIX. **Kahana, S.; Lee, H. C.; Scott, C. K. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev.; 185: 1378-1400(20 Sep 1969).**

The Brueckner reaction matrix for the A = 18 nuclei is obtained in an accurate fashion from a nonlocal separable potential of the Tabakin type, but possessing a much stronger repulsive core. This potential, as well as those of Tabakin and Yamaguchi, is used in comparative studies of the reaction matrix. Both harmonic-oscillator and plane-wave intermediate states are employed. The results are compared extensively to the work by other authors on the local Hamada–Johnston potential. In the plane-wave treatment, the effect of replacing the kinetic-energy operator by a form (suggested by Baranger) more compatible with the exclusion principle is estimated. (auth)

11043 COMPREHENSIVE FORMALISM FOR NUCLEAR-REACTION PROBLEMS. III. CALCULABLE THEORIES WITH SYSTEMATIC "DISCRETIZATION". **Lane, A. M. (Univ. of Colorado, Boulder); Robson, D. Phys. Rev.; 185: 1403-15(20 Sep 1969).**

The comprehensive formalism of earlier papers is specialized in the direction of calculable theories of nuclear reactions, especially those based on the shell model such as that of Bloch and Fano. Unlike the basic states used in previous specialization, the shell-model states do not, in general, have the property that (H + $\mathcal{D}$) is Hermitian. It is shown that this complication is no real obstacle, and that only a weaker Hermiticity condition is needed. The final result is a number of forms of calculable theories of the R-matrix kind. No continuum-continuum interaction problems exist, since continua do not occur. This and other merits of the results are discussed from the viewpoint of practical calculations. (auth)

11044 MICROSCOPIC DESCRIPTION OF THE INELASTIC PROTON DECAY OF ANALOG RESONANCES. **Zaidi, S. A. A.; Dyer, P. (Univ. of Texas, Austin). Phys. Rev.; 185: 1332-50(20 Sep 1969).**

A microscopic description of analog resonances is presented in the framework of the shell-model theory. The separation of the Hamiltonian into an independent-particle Hamiltonian H_0 and the residual interaction V is discussed. A choice of H_0 is made that minimizes the residual interaction—in particular, the matrix elements between the continuum eigenstates of H_0. The diagonalization of the two-body residual interaction on an appropriately chosen set of 2p-1h configurations is carried out, and the numerical results are presented for ^{209}Bi. A group of $\frac{9}{2}^+$ states of analog spin $W_<$ is predicted to be about 11 MeV below the $g_{\frac{9}{2}}$ analog resonance in ^{209}Bi. Coupling of the various continua to the $W_>$ state gives rise to the isobaric analog resonance in the corresponding channels. The inelastic proton decay of the $g_{\frac{9}{2}}$ analog resonance in ^{209}Bi to the particle-hole states of ^{208}Pb is calculated, and the results are compared with experimental data. An expression for the energy-average S-matrix elements is derived starting from the multilevel expression describing the coupling of both $T_>$ and $T_<$ states to the various continua. There expressions differ from those given by Weidenmueller and by Mekjian and MacDonald and are in agreement with Robson's results in the one-channel case. The expressions also agree with recent results obtained by Tamura. (auth)

11045 K-MATRIX THEORY OF THE ISOBARIC ANALOG RESONANCES. **Tamura, Taro (Univ. of Texas, Austin). Phys. Rev.; 185: 1256-78(20 Sep 1969).**

A theory of the isobaric analog resonances is formulated on the basis of the shell-model approach to reaction theory. By extending the K-matrix theory, originally formulated by MacDonald and Mekjian for a similar purpose, forms of S-matrix elements amenable to various direct numerical calculations are obtained. The formalism thus allows one to discuss most of the known characteristic features of the isobaric analog resonances, such as their asymmetric forms and the superposition of fine structures. It can also be used to extract the spectroscopic factors from the (p,p_0) and p,p′) data and to analyze the (p,n) data, all via isobaric analog resonances. Further discussions are presented on the use of the results in the analyses of nucleon transfer reactions to or via the isobaric analog states. (auth)

11046 MATHEMATICAL ASPECTS OF REFINED CLUSTER FUNCTIONS. I. **Hackenbroich, Hans H. (Univ., Tuebingen, Ger.). Z. Phys.; 231: 216-24(1970).**

The mathematical description of nuclear bound states is considered using refined cluster model functions. The intent is first to reduce matrix elements to sums of well specified integrals and then to evaluate these integrals analytically. Using present day computers, the method appears at least practical for calculating nuclear bound states up to A = 16, starting from realistic nucleon–nucleon potentials. (auth)

11047 MATHEMATICAL ASPECTS OF REFINED CLUSTER FUNCTIONS. II. **Hackenbroich, Hans H.; Heiss, Peter (Univ., Tuebingen, Ger.). Z. Phys.; 231: 225-9(1970).**

The refined cluster model theory of bound states is extended to describe reactions of nuclei. The intent of the method given is to use sets of linear matrix equations only which can be derived in close analogy to the procedure given in the first paper of this series. (auth)

11048 ^{5}He SCATTERING STATES IN THE REFINED CLUSTER FUNCTION REPRESENTATION. Heiss, P.; Hackenbroich, H. H. (Univ., Cologne). Z. Phys.; 231: 230-6(1970).

As a first application of the refined cluster model reaction theory the scattering states of ^{5}He using a specific ansatz for the nucleon-nucleon forces are calculated. ^{4}He-n and ^{3}H-d channels are considered only. The results agree qualitatively with the experimental values if available; in particular the narrow resonance in the $D_{\frac{5}{2}}$ ^{4}He-n channel as a consequence of the strong coupling to the $S_{\frac{1}{2}}$ T-d channel is explained. (auth)

11049 PROPERTIES OF PAIRING IN NUCLEI DEMONSTRATED IN A SOLVABLE MODEL. Mueller-Schwartz, J. (Max-Planck-Institut fuer Kernphysik, Heidelberg). Z. Phys.: 231: 237-42(1970).

In the sense of a simulation a model is considered which is to reflect the effect of the residual interaction at the nuclear surface. It consists of two energetically separated shells of equal one-particle spin and opposite parity. Initially the lower level is filled and the upper empty. The short-range nuclear force taken as a δ-force is considered. The model is considered for equivalent particles and extended to protons and neutrons. The energy spectra of both types for $j = \frac{3}{2}$ are similar, and resemble real spectra of even nuclei. For the equivalent particles, the BCS theory leads to a good approximation of the ground-state wave function, if after the variation the projection to definite particle number is performed. For the case of protons and neutrons, mixing of them and performing projection prior to the variation proves to be necessary. It is suggested that here the mixing of the parity is also important. In the configurations of the model a new sort of pairing matrix elements appears, which are larger than any other matrix elements, and act between two-particle states with $J = T = 0$ and $\Pi = -1$. (auth)

11050 NUCLEAR-STRUCTURE CALCULATIONS IN THE CONTINUUM: APPLICATION TO NEUTRON-CARBON SCATTERING. Purcell, J. E. (Florida State Univ., Tallahassee). Phys. Rev.; 185: 1279-85(20 Sep 1969).

An explicit method for calculating the scattering matrix from a given structure-model Hamiltonian is presented. The special technique adopted uses nonorthogonal eigenfunctions of the basic model Hamiltonian to represent the scattering wave functions in the interaction region. Application of this approach is made to neutron scattering by ^{12}C. The weak-coupling particle-rotator model was used for the positive-parity states of ^{13}C. The results obtained agree closely with the experimental total neutron cross section, both the background and resonant behavior being well reproduced by the theory. (auth)

11051 SHELL-MODEL COMBINATORIAL CALCULATIONS OF NUCLEAR LEVEL DENSITIES. Hillman, Manny; Grover, J. Robb (Brookhaven National Lab., Upton, N. Y.). Phys. Rev.: 185: 1303-19(20 Sep 1969).

Spin-dependent nuclear level densities were calculated for selected nuclides. In each case the numbers and spins of the levels were determined from a computer-generated list of all contributing shell-model configurations. To calculate the energies of the configurations, the model nucleus was assumed to be an infinitely deep spherical well containing fermions that are noninteracting except for pairing forces, for which the BCS theory was used. Comparisons of the calculated results with experimental level densities for odd, even, and odd-mass nuclides show reasonable agreement for nuclides with $A > 50$. The results of calculative investigations of the effects of shell closings, pairing, etc., and the persistence of these effects to high excitation energies and angular momenta are reported and discussed. Comparisons of these results with those obtained from the most commonly used algebraic formula show significant disagreements in the curvature of the logarithmic energy dependence and in the spin distributions. (auth)

11052 PERTURBATION THEORY AND THE FEW-NUCLEON SYSTEM. Lim, T. K. (Florida State Univ., Tallahassee). Nucl. Phys.; A139: 149-60(1969).

Rayleigh–Schrödinger perturbation theory is used to study the three- and four-nucleon systems in which nucleons are assumed to interact via pairwise central Gaussian potentials with and without repulsive soft cores. The perturbational procedure is started off by replacing each effective nucleon–nucleon interaction by a harmonic oscillator, whose angular frequency is varied to achieve "maximum" convergence of the energy eigenvalue to third order. The efficiency and accuracy of this approach are shown by a direct comparison of our results and those obtained by variational methods in the evaluation of the binding energy, r.m.s. radius, Coulomb energy and form factor in the tri-nucleon and ^{4}He. (auth)

11053 REACTION MECHANISM INDEPENDENT PARTICLE-GAMMA CORRELATION FUNCTIONS USING POLARIZED PARTICLES. McCullen, J. D. (Univ. of Arizona, Tucson); Seyler, R. G. Nucl. Phys.; A139: 203-8(1969).

The use of polarized particles in particle–gamma correlation experiments permits the extraction of the spectroscopic information in a manner independent of the reaction mechanism. Two methods for doing this are proposed. The results extend reaction-independent techniques to virtually any common projectile-outgoing particle reaction. (auth)

11054 DERIVATION OF THE DWBA IN AN EXACT THREE-PARTICLE THEORY. Alt, E. O.; Grassberger, P.; Sandhas, W. (Univ., Bonn). Nucl. Phys.; A139: 209-25(1969).

Starting from the exact formulation of the three-particle problem in terms of a set of coupled multi-channel "two-particle" Lippmann–Schwinger equations, expressions are derived for the transition amplitudes for rearrangement scattering which closely resemble the DWBA for this process. Conditions for their validity are given. Inelastic scattering and break-up processes are also treated. The transition potentials are calculable from the original two-particle potentials by means of a series expansion. The lowest-order term of this expansion consists of two parts only one of which corresponds to the usual DWBA term. Its precise form is correlated to the definition of the optical potential. An approximation leads to an absorption model with unitarity corrections which can also be derived by a K-matrix approach. (auth)

11055 NUCLEAR SINGLE-PARTICLE POTENTIALS AND NATURAL ORBITALS. Kirson, Michael W. (Weizmann Inst. of Science, Rehovoth, Israel). Nucl. Phys.; A139: 57-68(1969).

The criterion of maximal cancellation of insertions for defining a single-particle potential in nuclei is reconsidered in the light of Kobe's alternate criterion of compensation of dangerous diagrams. The structure of a general reaction matrix perturbation expansion is carefully investigated, and it is concluded that the extended factorization procedure used to generate the maximal cancellation criterion may equally well be used to reduce the perturbation expansion for any choice of single-particle potential, and hence that maximal cancellation is not directly related to convergence of the expansion. The two criteria are found to be complementary, in the sense that both give rise to computational simplifications, each retaining complications avoided in the other. Despite the elegance and intuitive appeal of the Kobe criterion, this analysis suggests that it is not useful to seek a "best" single-particle potential for reaction-matrix calculations, but that the potential should be tailored to the calculation performed, with due regard for correction terms. (auth)

11056 THE ALGEBRA OF CURRENTS AS A COMPLETE DYNAMICAL METHOD IN THE NUCLEAR MANY-BODY PROBLEM: APPLICATION TO AN EXACTLY SOLUBLE MODEL. Dreiss, Gerard J. (Northeastern Univ., Boston); Klein, Abraham. Nucl. Phys.; A139: 81-99(1969).

A method for obtaining approximate solutions to the standard shell-model problem, as applied to collective states, is described which exploits two features of such problems. One is the completely general mathematical feature that the Hamiltonian is a simple polynomial in the generators of a Lie group. The second is the widespread physical feature that when the matrix element of a product of generators, taken between suitable low-lying states, is evaluated by sum rule techniques, the intermediate state sums are exhausted by a few terms (collective states). Such sum rule techniques can be applied to the Lie algebra, the Casimir operators of the algebra (whose eigenvalues specify the representations appropriate to the fermion system under study), to the condition that the Hamiltonian be diagonal in the space of its eigenstates, and to the equations of motion for the generators taken between such states. In this paper the technique is applied to an exactly soluble model introduced by Meshkov, Lipkin, and Glick. It is seen that the sum rules can be cut at various levels of approximation and with sufficient care in the way this is done that the resulting systems of non-linear equations among physical matrix elements constitutes a complete (or even overcomplete but reasonably self-consistent) dynamical scheme for the computation of a specified set of physical quantities. Even the crudest such approximation gives qualitatively reasonable results right through the phase transition exhibited by the model. The best approximation carried out yields all the physical quantities associated with the lowest four eigenstates of the system, i.e. up to three phonon-states in the vibrational regime. Essentially exact results for all coupling constants are obtained for the quantities normally calculated by the random phase approximation and good values for the remaining quantities. The strength of the method is seen to be that for systems with collective modes, the complexity of

its application depends only on the structure of the group studied and on the number of physical states taken into account and is independent of the total number of particles treated. (auth)

11057 MODEL APPLICATION OF A NUCLEAR ROTATION THEORY. Nadjakov, E.; Sivriev, I.; Karadjov, D.; Piperova, Y. (Inst. of Physics, Sofia). Compt. Rend. Acad. Bulg. Sci.; 22: 871-4(1969).

It is shown that deviations from the simple rotational formula for rotational-band energy levels can be accounted for in the framework of the two-dimensional soft-rotator model. (J.W.R.)

11058 EFFECT OF MIXING OF STATES ON NUCLEAR ROTATIONAL LEVEL EXCITATION BY HEAVY PARTICLES. Tishchenko, B. I. (Physical-Technical Inst., Kharkov). Yadern. Fiz.; 10: 959-63(Nov 1969). (In Russian).

General expressions are obtained which characterize the cross sections of nuclear rotational states excited by heavy particles in case of mixing of rotational bands of the nucleus. It is shown that the experimental data on the scattering of heavy particles by atomic nuclei make it possible to see the presence of the state mixing and to estimate its value. The mixing coefficients of ^{23}Na nucleus rotational bands obtained from the experimental data on α-particle scattering on the ^{22}Na nucleus are in reasonable agreement with the results of the analysis of the scheme of levels of this nucleus on the basis of a generalized model. (auth)

11059 WAVE FUNCTION AND MATRIX ELEMENTS IN K-HARMONICS METHOD. Gorbatov, A. M. (Moscow Physical-Technical Inst.). Yadern. Fiz.; 10: 950-8(Nov 1969). (In Russian).

A new way is presented to construct the wave function and to calculate the matrix elements that arise when the K-harmonics method is applied to nuclei. A general expression for the matrix element is presented in a form ready for immediate use. (auth)

11060 POTENTIAL ENERGY DEPENDENCE ON QUANTUM NUMBERS OF UNITARY SYMMETRY SCHEME MODEL. Vanagas, V. V.; Kalinauskas, R. K. (Inst. of Physics and Mathematics, Vilnyus, USSR). Yadern. Fiz.; 10: 939-49(Nov 1969). (In Russian).

A general method for decomposition of the central internuclear interaction (with orbital exchanges) in terms of special forms of polylinear infinitesimal operators of the U(3(n – 1)) group is proposed. The properties of some types of those forms are investigated. Explicit expressions for calculating universal relations which allow one to study the potential energy dependence on the quantum numbers of the unitary symmetry scheme model are presented. The SU(3) invariant energy expression is given in case of the ground and oscillatory-excited states in p and sd nuclei. (auth)

11061 DETERMINATION OF THE ACTUAL DISTANCE COVERED BY RECOIL NUCLEI FROM SPALLATION BY THE TRACK METHOD. Brito, Ubirajara (CNRS, Gif-sur-Yvette, France. Centre d'Etudes Nucleaires de Saclay, Gif-sur-Yvette, France). Compt. Rend., Ser. B; 269: 333-6 (25 Aug 1969). (In French).

The experimental study of the relation existing between the track length and atomic mass of recoil nuclei from spallation permits the determination of a probable length of the residual distance covered by spallation fragments when the latter are not capable of ionizing the detector. It is probable that, in this area, the energy losses by secondary ionization are negligible in proportion to the energy losses by primary ionization associated with the impact. (tr-auth)

REACTOR TECHNOLOGY

Commercial Power Reactors

Refer also to abstracts 9549, 9574, 10011, 10206, and 11323.

11062 (AECL-3452) COMPUTER CONTROL ON CANADIAN NUCLEAR REACTORS. Pearson, A. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Oct 1969. 22p. (CONF-691009-5). Dep. CFSTI (U. S. Sales Only). AECL $1.00.

From Conference on Reactor Operating Experience, San Juan, Puerto Rico.

Experiences with the NRU Reactor and CANDU Reactor computer control systems are presented. Computer control systems for the Gentilly Power Reactor, Karachi Power Reactor, and the Pickering Power Reactor Unit 1 are described. 5 references. (D.C.C.)

11063 (DLCS-5000269) QUARTERLY OPERATING REPORT. Second Quarter, 1969. (Duquesne Light Co., Shippingport, Pa. Power Stations Dept.). Contract AT(11-1)-292. 25p. Dep. CFSTI.

Operation and maintenance requirements during April to June 1969 are described. Coolant chemistry during the quarter is analyzed. Refueling procedures are described. Testing programs are reviewed. (D.C.C.)

11064 (DOCKET-50003-18) INDIAN POINT STATION, [UNIT NO. 1]. Survey of Environmental Radioactivity, February 1–July 31, 1969. (Consolidated Edison Co. of New York, Inc., New York). 30 Dec 1969. 19p. Dep. CFSTI.

11065 (DOCKET-50010-61) DRESDEN NUCLEAR POWER STATION, UNIT 1. Failure of Control Transformers on Two Motor Operated Valves. (Commonwealth Edison Co., Chicago, Ill.). 15 Dec 1969. 1p. Dep. CFSTI.

11066 (DOCKET-50010-62) [DRESDEN NUCLEAR POWER STATION, UNIT 1]. License No. DPR-2. Technical Specifications Change No. 20. (Commonwealth Edison Co., Chicago, Ill.). 31 Dec 1969. 5p. Dep. CFSTI.

Modifications in stack discharge calculations and operating limits are described. Personnel requirements for normal operation are presented. (D.C.C.)

11067 (DOCKET-50010-63) DRESDEN NUCLEAR POWER STATION, UNIT 1. Leak in the Reactor Vent Piping. [Unusual Occurrence Report]. (Commonwealth Edison Co., Chicago, Ill.). 6 Jan 1970. 3p. Dep. CFSTI.

A leak in the forged stainless steel reducer on the reactor vent piping in the Dresden Power Reactor, Unit 1 is described. Remedial measures and subsequent hydrostatic, dye penetrant, and ultrasonic testing are outlined. (M.L.S.)

11068 (DOCKET-50016-28) ENRICO FERMI ATOMIC POWER PLANT, [UNIT 1]. [Operations] Report, August 1969. (Power Reactor Development Co., Detroit, Mich.). 19 Dec 1969. 11p. (PRDC-EF-72). Dep. CFSTI.

11069 (DOCKET-50016-29) ENRICO FERMI ATOMIC POWER PLANT, [UNIT 1]. [Operations] Report, September 1969. (Power Reactor Development Co., Detroit, Mich.). 14 Jan 1970. 18p. (PRDC-EF-73). Dep. CFSTI.

11070 (DOCKET-50016-30) [ENRICO FERMI ATOMIC POWER PLANT, UNIT 1]. License No. DPR-9. Technical Specifications Change No. 19. (Power Reactor Development Co., Detroit, Mich.). 12 Jan 1970. 92p. Dep. CFSTI.

Safety limits for reactor components are described. Qualifications for operating personnel are reviewed. Radiation emergency procedures are described. (D.C.C.)

11071 (DOCKET-50029-111) YANKEE NUCLEAR POWER STATION. Operation Report No. 108, December 1969. (Yankee Atomic Electric Co., Westboro, Mass.). 20 Jan 1970. 8p. Dep. CFSTI.

11072 (DOCKET-50155-16) [BIG ROCK POINT NUCLEAR PLANT]. License No. DPR-6. Technical Specifications, Change No. 19. (Consumers Power Co., Jackson, Mich.). 22 Dec 1969. 16p. Dep. CFSTI.

Design characteristics of PuO_2–UO_2 fuel elements are described. Accident analysis for the fuel elements is presented. (D.C.C.)

11073 (DOCKET-50155-17) BIG ROCK POINT NUCLEAR PLANT. Semiannual Report No. 11, May 1–October 31, 1969. (Consumers Power Co., Jackson, Mich.). 22 Dec 1969. 12p. Dep. CFSTI.

11074 (DOCKET-50171-19) PEACH BOTTOM ATOMIC POWER STATION, [UNIT 1]. Monthly Operations Report No. 39, May 1969. (Philadelphia Electric Co., Pa.). 10 Jul 1969. 11p. Dep. CFSTI.

11075 (DOCKET-50171-20) [PEACH BOTTOM ATOMIC POWER STATION, UNIT 1]. Request for Change in Technical Specifications (No. 11). (Philadelphia Electric Co., Pa.). 31 Dec 1969. 16p. Dep. CFSTI.

Modifications of inspection procedures for core components are presented. Radiation effects on core components are described. (D.C.C.)

11076 (DOCKET-50171-21) PEACH BOTTOM ATOMIC POWER STATION, [UNIT 1]. Monthly Operations Report No. 45, November 1969. (Philadelphia Electric Co., Pa.). 14 Jan 1970. 12p. Dep. CFSTI.

11077 (DOCKET-50213-27) [CONNECTICUT YANKEE ATOMIC POWER PLANT]. Operation Report No. 69-11, November 1969. (Connecticut Yankee Atomic Power Co., Haddam). 22 Dec 1969. Contract AT(30-1)-3250. 16p. (NYO-3250-42). Dep. CFSTI.

11078 (DOCKET-50213-28) [CONNECTICUT YANKEE ATOMIC POWER PLANT]. License No. DPR-14. Supplement to Proposed Change No. 12. (Connecticut Yankee Atomic Power Co., Hartford). 29 Dec 1969. 4p. Dep. CFSTI.

Proposed changes in the test assemblies for Core 2 are presented. The four test assemblies that will be added consist of two stainless steel clad and two Zircaloy-4 clad assemblies. Design parameters for the assemblies are included. (D.C.C.)

11079 (DOCKET-50213-29) [CONNECTICUT YANKEE ATOMIC POWER PLANT]. Operation Report No. 69-12, December 1969. (Connecticut Yankee Atomic Power Co., Haddam). 15 Jan 1970. Contract AT(30-1)-3250. 11p. (NYO-3250-43). Dep. CFSTI.

11080 (DOCKET-50219-62) [OYSTER CREEK NUCLEAR POWER PLANT, UNIT NO. 1]. Main Steam Isolation Valves. (Jersey Central Power and Light Co., Morristown, N. J.). 24 Dec 1969. 2p. Dep. CFSTI.

Pressure rise rates for main steam isolation valves are analyzed. The possibility of a leaking valve is discussed. Proposed corrective procedures are described. (D.C.C.)

11081 (DOCKET-50237-28) DRESDEN NUCLEAR POWER STATION, UNITS 2 AND 3. Current State of Knowledge High Performance BWR Zircaloy-Clad UO_2 Fuel. [Safety Analysis Report], Amendment 14 for Unit 2 and Amendment 15 for Unit 3. (Commonwealth Edison Co., Chicago, Ill.). 25 Jul 1969. 61p. (DOCKET-50249-28). Dep. CFSTI.

Details of the current state of knowledge on high performance boiling water reactor Zircaloy-clad uranium dioxide fuel are given. General Electric's experience with operating production fuel is detailed; data are shown graphically and tabularly. Other experience with boiling water reactor fuels are summarized. Predicted-to-observed performance characteristics are compared. Outlines of stability tests to be performed during startup are given. (M.L.S.)

11082 (DOCKET-50237-29) [DRESDEN NUCLEAR POWER STATION, UNITS 2 AND 3]. [Changes to Correct Training, Qualifications, and Manning Requirements]. [Safety Analysis Report], Amendment 15 for Unit 2 and Amendment 16 for Unit 3. (Commonwealth Edison Co., Chicago, Ill.). 5 Aug 1969. 20p. (DOCKET-50249-29). Dep. CFSTI.

Changes in training, qualifications, and manning requirements for Dresden Power Reactor, Units 2 and 3 are given. Methods for review, approval and authorization of changes in procedures are described. (M.L.S.)

11083 (DOCKET-50237-30) DRESDEN NUCLEAR POWER STATION, UNITS 2 AND 3. Answers to AEC Questions. [Safety Analysis Report], Amendment 16 for Unit 2 and Amendment 17 for Unit 3. (Commonwealth Edison Co., Chicago, Ill.). 11 Aug 1969. 23p. (DOCKET-50249-30). Dep. CFSTI.

Population data for the area adjacent to the Dresden site are listed. Damage protection for the spent fuel storage pool for Dresden Power Reactor, Units 2 and 3 is described. Codes and standards for nondestructive testing of safety and relief valves are given. The startup organization and personnel qualifications are described. Revised drawings for the Emergency Core Cooling Systems are included. (M.L.S.)

11084 (DOCKET-50237-35) [DRESDEN NUCLEAR POWER STATION, UNIT 2]. Control Rod Drive (CRD) Surveillance During Start-Up Test Program. (Commonwealth Edison Co., Chicago, Ill.). 15 Nov 1969. 9p. Dep. CFSTI.

Proposed changes in the testing and chemistry control programs for the Dresden Power Reactor, Unit 2 are described. Control rod scram times and experiences in testing of the scram systems at Oyster Creek and Nine Mile Point are detailed as evidence for the proposed Dresden testing modifications. (M.L.S.)

11085 (DOCKET-50237-36) DRESDEN NUCLEAR POWER STATION, UNIT 2. Operating License DPR-19; Technical Specifications. (Commonwealth Edison Co., Chicago, Ill.). 22 Dec 1969. 209p. Dep. CFSTI.

11086 (DOCKET-50237-37) [DRESDEN NUCLEAR POWER STATION, UNIT 2]. Cobalt Demonstration Capsules. Proposed Modification No. 70-1 to Safety Analysis Report. (Commonwealth Edison Co., Chicago, Ill.). 31 Dec 1969. 16p. Dep. CFSTI.

Modification of the core for 4 capsules of ^{60}Co is described. The effects of the capsules on the hydraulic, mechanical, nuclear, and thermal characteristics of the core are analyzed. Accident analysis for the capsules is included. (D.C.C.)

11087 (DOCKET-50237-38) [DRESDEN NUCLEAR POWER STATION, UNIT 2]. Fuel Bundle Deposition Inserts. Proposed Modification No. 70-2 to Safety Analysis Report. (Commonwealth Edison Co., Chicago, Ill.). 15 Jan 1970. 11p. Dep. CFSTI.

Modifications for nose pieces of four fuel elements are described. The modified nose pieces consist of two insulated and two noninsulated Zircaloy-2 inserts. Iron deposits on the modified nose pieces will be analyzed for possible cause of deposition. (D.C.C.)

11088 (DOCKET-50244-34) [ROBERT GINNA STATION, UNIT NO. 1]. Malfunction of Safeguards Valve MOV-850 B. (Rochester Gas and Electric Corp., N. Y.). 23 Dec 1969. 2p. Dep. CFSTI.

11089 (DOCKET-50259-10) BROWNS FERRY NUCLEAR PLANT, [UNITS 1, 2, AND 3]. Environmental Radioactivity Levels. Semiannual Report, January-June 1969. (Tennessee Valley Authority, Chattanooga. Office of Power). 12 Jan 1970. 41p. (DOCKET-50260-10; DOCKET-50296-10). Dep. CFSTI.

11090 (DOCKET-50280-19) SURRY POWER STATION, UNITS 1 AND 2. Final Safety Analysis Report, Part B. Vol. 1. (Virginia Electric and Power Co., Richmond). 21 Jan 1970. 562p. (DOCKET-50281-19). Dep. CFSTI.

Information on Survey Power Reactor Units 1 and 2 is presented under the following broad topics: Introduction and Summary; Site; and Reactor. (D.C.C.)

11091 (DOCKET-50280-20) SURRY POWER STATION, UNITS 1 AND 2. Final Safety Analysis Report, Part B, Vol. 2. (Virginia Electric and Power Co., Richmond). 21 Jan 1970. 599p. (DOCKET-50281-20). Dep. CFSTI.

Information on Surry Power Reactor Units 1 and 2 is presented under the following broad topics: Reactor Coolant System; Containment System; Engineered Safeguards; and Instrumentation and Control. (D.C.C.)

11092 (DOCKET-50280-21) SURRY POWER STATION, UNITS 1 AND 2. Final Safety Analysis Report, Part B, Vol. 3. (Virginia Electric and Power Co., Richmond). 21 Jan 1970. 599p. (DOCKET-50281-21). Dep. CFSTI.

Information on Surry Power Reactor Units 1 and 2 is presented under the following broad topics: Electrical Systems; Auxiliary and Emergency Systems; Steam and Power Conversion System; and Radioactive Wastes and Radiation Protection. (D.C.C.)

11093 (DOCKET-50280-22) SURRY POWER STATION, UNITS 1 AND 2. Final Safety Analysis Report, Part B, Vol. 4. (Virginia Electric and Power Co., Richmond). 21 Jan 1970. 702p. (DOCKET-50281-22). Dep. CFSTI.

Information on Survey Power Reactor Units 1 and 2 is presented under the following broad topics: Conduct of Operations; Initial Tests and Operations; Safety Analysis; and Structures and Construction. (D.C.C.)

11094 (DOCKET-50293-22) PILGRIM NUCLEAR POWER STATION. Final Safety Analysis Report, Vol. 3. [Preliminary Safety Analysis Report, Amendment 12]. (Boston Edison Co., Mass.). 12 Jan 1970. 255p. Dep. CFSTI.

Information on Pilgrim Power Reactor is presented under the following broad topics: Power Conversion System; Structures and Shielding; Conduct of Operations; and Station Safety Analysis. The Appendix provides information on pressure integrity of piping systems and components. (D.C.C.)

11095 (GAMD-9735) TUBE SUPPORT DAMPING FORT ST. VRAIN STEAM GENERATOR. Kellar, W. (Gulf General Atomic, Inc., San Diego, Calif.). 15 Nov 1969. Contract AT-(04-3)-633. 26p. Dep. CFSTI.

The damping data presented were obtained from a representative structure but many important factors were not considered. The GAVEL wedge test data match effects of air density and temperature, but do not include frequency effects. Fort St. Vrain sleeve/wedge test data do not include helium density, temperature, or frequency effects. The GAVEL wedge data are intentionally biased to the lower magnification factor values. Application of these values produces conservatively high lift coefficients. Similarly, the Fort St. Vrain sleeve/wedge data are based on the higher magnification factor from in-plane preloading, which gives conservatively high stresses and deflections. Conservative values of Fort St. Vrain magnification factor have been determined for the GAVEL wedge and the Fort St. Vrain sleeve/wedge. 7 references. (auth)

11096 (IN-1326) PRELIMINARY RESULTS AND TEST EXPERIENCE OF THE CAROLINAS VIRGINIA TUBE REACTOR CONTAINMENT LEAKAGE RATE TESTS. Bingham, G. E.; Norberg, J. A.; Schmitt, R. C.; Waddoups, D. A. (Idaho Nuclear Corp., Idaho Falls). Dec 1969. Contract AT(10-1)-1230. 60p. Dep. CFSTI.

Containment leakage rate tests were performed on the Carolinas Virginia Tube Reactor to investigate the effects of pressure, temperature, and design basis accident (DBA) conditions on containment leakage rate. The results of these tests as well as the instrumentation used, the test procedures, and the problems encountered are presented. 8 references. (auth)

11097 (IRS-T-16(1969)) THE SAFETY OF SITE-INDEPENDENT NUCLEAR POWER PLANTS. 4th Technical Meeting of the Institute for Reactor Safety of the TUV, Duesseldorf, November 4-5, 1968. (Technischer Ueberwachungs-Verein e. V., Cologne (West Germany). Institut fuer Reaktorsicherheit). 102p. (In German). (CONF-681128).

Included are 4 papers on safety aspects of siting large power reactors near areas of high population density. A separate abstract was prepared for each paper. (H.D.R.)

For abstracts of individual papers see: 11098-11101.

11098 (IRS-T-16(1969), pp 3-10) FUTURE CHALLENGES OF ELECTRIC UTILITIES IN GERMANY. Keltsch, E. (Technischer Ueberwachungs-Verein e. V., Cologne (West Germany). Institut fuer Reaktorsicherheit). (In German).

Presently, 375 power stations supply the public power grid in the Federal Republic of Germany. When government support of coal expires, a rapid shift toward nuclear power stations is anticipated. For economic reasons, each station will have a power of 600 MW(e) or higher. Approximately 12 such stations could supply the entire energy requirement of West Germany. The bridging of sudden power peaks by conventional plants and gas turbines is discussed. The projected large nuclear power stations would be interconnected by a 380 kilowatt power grid. Energy transmission by superconducting cables or by short wave are evaluated from economic and technical standpoints. (H.B.G.)

11099 (IRS-T-16(1969), pp 13-25) IS IT NECESSARY TO BUILD NUCLEAR POWER STATIONS CLOSE TO AREAS OF ENERGY CONSUMPTION. Kellermann, O. (Technischer Ueberwachungs-Verein e. V., Cologne (West Germany). Institut fuer Reaktorsicherheit). (In German).

Industries that require process steam make it necessary to locate nuclear power stations close to points of consumption. For pure electricity production, the answer is not as clearcut; however, several points favor location of large power plants close to population and industrial centers. Cooling water requirements for a six hundred MW(e) station is roughly 38 m^3/sec of which 10% can be evaporated for cooling. Therefore, the power station must be

located close to a fair size river at which, usually, cities are also located. Economics show that one third of electricity cost rests in production, one third in long distance transmission, and one third in final distribution. Obviously, the long distance can be largely decreased by location close to consumption centers. Conservation of landscape also recommends location close to cities. Calculation shows that 30 km transmission costs as much as do all the necessary security measures. Therefore, it is more economical to build power stations with high safety features rather than build them in remote areas. Radioactive measurements show that the various types of German coal release as much ^{210}Po as nuclear power stations release radioactivity. (H.B.G.)

11100 (IRS-T-16(1969), pp 33-40) RELATIONSHIP BETWEEN SITE AND SAFETY OF NUCLEAR POWER STATIONS. Schwarzer, W. (Technischer Ueberwachungs-Verein e. V., Cologne (West Germany). Institut fuer Reaktorsicherheit). (In German).

Based on population density, weather conditions, and prevailing winds, a mathematical formula is developed for the assessment of radiation exposure in the case of an accidental disturbance. The release of ^{131}I is taken as the base criterion. Small amounts of accidental release predominantly endanger populations close to the station. Amounts of one megacurie expose people within a 50 km radius to 2000 REM thyroidal radiation. Due to the high population density in West Germany, any injury to the population practically is independent from the site selection of a power station. The same conclusion is reached for cases of sabotage or enemy action during war. Therefore, with sufficient safety measures, power stations can be located close to population centers. However, site selection has to consider the possibilities of floods, earthquakes, airplane crashes near airports, and explosions in ammunition factories and large oil tanks. (H.B.G.)

11101 (IRS-T-16(1969), pp 55-66) SAFETY MEASURES FOR SITE-INDEPENDENT NUCLEAR POWER STATIONS. Jahns, A. (Technischer Ueberwachungs-Verein e. V., Cologne (West Germany). Institut fuer Reaktorsicherheit). (In German).

Safety procedures for boiling water reactors are reviewed. The worst case of accident, rupture of the primary cooling system, is discussed. To prevent core melting, the installation of an emergency cooling system is suggested. In addition, procedures for the prevention of fission product release are discussed. 22 references are given. (H.B.G.)

11102 (ORNL-tr-2250) DESIGN OF PRESTRESSED CONCRETE REACTOR VESSELS: THE DOUBLE-LAYER PROCESS. Lacroix, Roger. Translated for Oak Ridge National Lab., Tenn., from Ann. Inst. Tech. Batiment Trav. Publics; 22: 1403-31(1969). 53p. Dep. CFSTI.

Design and fabrication techniques for prestressed concrete pressure vessels are described. Testing procedures are included. Fabrication of the Bugey Reactors (EDF-S) prestressed concrete pressure vessel is described. (D.C.C.)

11103 (STI/PUB-21/30(Vol.2)) NUCLEAR POWER ECONOMICS. VOL. II (1964-1967). Bibliographical Series No. 30. (International Atomic Energy Agency, Vienna (Austria)). Apr 1968. 303p. IAEA $6.00.

This bibliography contains 1486 references to the literature in English, French, Russian, German, Italian, Spanish, and other languages which was published during the period 1964 to 1967. Most of the references are provided with abstracts. Topics include: general aspects of nuclear power; economic evaluation of power reactors; economics of nuclear fuels; economics of power reactor components; water desalination and heat production economics; nuclear propulsion economics; other economic aspects; and author index. The material under each heading is listed alphabetically by author and, when no personal or corporate author is given, by title. Titles and abstracts are in English, with the original language, where relevant, indicated in parentheses. (auth)

11104 (STI/PUB-188) ECONOMICS OF NUCLEAR FUELS. Proceedings Series. Proceedings of the Symposium held in Gottwaldov, 27-31 May 1968. (International Atomic Energy Agency, Vienna (Austria)). 1968. 618p. (In several languages). (CONF-680541). IAEA $14.50.

Thirty-five papers were presented at the conference. A separate abstract was prepared for each paper. (J.R.D.)

For abstracts of individual papers see: 9461-9463, 9569, 9570, 9608, 9629, 11120-11146, and 11279.

11105 (TID-25289) GUNDREMMINGEN NUCLEAR POWER PLANT. Monthly Report, September 1969. (Kernkraftwerk RWE-Bayernwerk G.m.b.H., Gundremmingen (West Germany)). 44p. (In German). Dep. CFSTI.

In order to minimize the stressing of the fuel elements the plant was operated continuously at full load throughout the period under review. The waste-gas activity at the condenser increased to about 35 mCi/sec after full load had been reached and then remained constant. Difficulties with the in-core measurement (some of the chambers repeatedly gave fluctuating readings which were not due to the flux) would probably have resulted in load reductions if the power had been altered. The causes of the defects are still being investigated. (auth)

11106 (TID-25290) GUNDREMMINGEN NUCLEAR POWER PLANT. Monthly Report, October 1969. (Kernkraftwerk RWE-Bayernwerk G.m.b.H., Gundremmingen (West Germany)). 44p. (In German). Dep. CFSTI.

Throughout the report period the plant was operated under full load. As in September the level of off-gas activity was between 30 and 35 mCi/sec. The preparations for the further inspection and possible repair of the fuel elements removed from the core are complete, so that as from November work can begin on the actual inspection and repair. Through extensive safety measures, thorough instruction and limitation of the staff working at any one time at elevation +31m to a maximum of five persons, it has been ensured that operations will not be affected by this work. For the absolute determination of the neutron flux in the reactor, irradiation samples were inserted in the core in place of a TIP chamber. (auth)

11107 (WCAP-3385-21) SAXTON PLUTONIUM PROJECT QUARTERLY PROGRESS LETTER FOR THE PERIOD ENDING SEPTEMBER 30, 1969. Smalley, W. R. (Westinghouse Electric Corp., Pittsburgh, Pa. Nuclear Fuel Div.). Nov 1969. Contract AT(30-1)-3385. 11p. Dep. CFSTI.

Fast neutron radiation effects on mechanical properties of Core 2 fuel rods are analyzed. Physics measurements for Core 3 are described. (D.C.C.)

11108 SEALING OF THE PIPE-PIPE PLATE CONNECTION IN THE CONDENSER OF THE DODEWAARD NUCLEAR POWER PLANT. Nooyens, A. J.; de Vries, H. Lastechniek; 34: 136-8 (May 1968). (In Dutch).

The examinations on the quality of the sealing of the cylinder connection of aluminum-brass condenser pipes and Muntz metal pipe plates are described. (tr-auth)

11109 NEEDS AND DEVELOPMENT LINES WITH REGARD TO ANALYSIS METHODS FOR COMMERCIAL POWER REACTORS. Kind, A.; Rinaldini, C. (CCR-EURATOM, Ispra, Italy). Energ. Nucl. (Milan); 16: 683-99(Nov 1969).

The attainment of commercial competitiveness of nuclear energy has led to new technical problems. One of these is the economic optimization of calculation techniques. A review of present calculational needs is given, followed by a comparative analysis of the various techniques which can be used. A summary of the calculation techniques most widely used by various organizations is given, together with a tentative analysis of possible development. 51 references. (auth)

11110 XENON TRANSIENTS: MANEUVERABILITY OF POWER CHANGES IN KARACHI NUCLEAR POWER PLANT. Huseini, S. D. Nucleus (Lahore); 6: 88-98(Apr-Jun 1969).

Calculations for xenon transients related to power cycles in the Karachi Power Reactor are analyzed. Optimum power cycle requirements are presented. (D.C.C.)

11111 A PROGRAM OF PREVENTIVE MAINTENANCE FOR NUCLEAR POWER PLANTS. Snyder, D. A. (Douglas United Nuclear, Inc., Richland, Wash). Nucl. News; 12: 50-3 (Dec 1969).

The requirements for an effective preventive maintenance program are described. Outlines for suggested maintenance schedules and records systems are included. 3 references. (D.C.C.)

11112 SIX YEARS OPERATING EXPERIENCE OF THE WINDSCALE AGR. Barton, L. Risley, Eng.; United Kingdom Atomic Energy Authority (1969). 33p.

An account is given of operating experience with the Windscale Advanced Gas-Cooled Reactor under the following headings: introduction; general performance; fuel performance; experience with general plant features; gas composition control; single channel access and fuel plug stringer design; refuelling route and refuelling machine; "gagging"; pressure circuit; boilers; circulators; heat losses and insulation problems; vibration problems; loops; and operational control and safety. (UK)

11113 NUCLEAR ENERGY IN THE ENERGY SUPPLY OF GREAT BRITAIN. Kroms, A. Bull. Schweiz. Elektrotech. Ver.: 285-96(9 Nov 1968).

Topics discussed include: programmes for integrating nuclear energy in the British network; first and second generation power stations; prospects of different reactor types, breeder reactors; and cost per kWh, conventional and nuclear. (UKAEA Info. Bull.)

11114 HOW DRESDEN EXPERIENCE BENEFITS NEW PLANTS. Redman, George (Commonwealth Edison Co., Chicago). Power; 112: No. 5, 72-3(May 1968).

A brief review of operating experiences during 1960 to 1967 is presented. (D.C.C.)

11115 STAFFING AND TRAINING FOR NUCLEAR POWER. Reed, G. A. (Wisconsin Michigan Power Co., Appleton, Wis.). Power; 112: No. 5, 88-91(May 1968).

Required personnel and personnel qualifications for power reactors are reviewed. Training schedules are outlined. (D.C.C.)

11116 HEAVY WATER IN CANADA'S POWER REACTORS. Rae, H. K.; Charlesworth, D. H.; Bancroft, A. R. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Eng. J. (Montreal); 52: 17-21(Dec 1969).

The unique nuclear properties of heavy water permit the extraction of 4×10^8 BTU/lb uranium in CANDU reactors giving a fueling cost of 0.6 mill/kWh. Heavy water (D_2O) costs about $20/lb because deuterium (D) occurs in nature at a low concentration and is difficult to separate from hydrogen. Separation is best achieved by chemical exchange reactions. (auth) (Canada)

11117 WATER FLOW VELOCITY MEASUREMENTS WITHIN THE DODEWAARD POWER REACTOR VESSEL BY CROSS CORRELATION OF THERMOCOUPLE OUTPUTS. Termaat, K. P. Electrotechniek, 47: 224-9(May 1, 1969). (In Dutch).

In the downcomer region of the reactor system of the 50 MW(e) Dodewaard Boiling Water Reactor with natural circulation, 30 pairs of fast response thermocouples are used to detect temperature fluctuations in the recirculating reactor water. After amplification and filtering, the signals of each thermocouple pair are fed into a multipoint polarity coincidence correlator to form the cross correlation function $C_{12}(k_{\Delta T})$. From this function the mean transit time τ_1 of the temperature fluctuations to cover the mutual distance 1 between the thermocouples is easily found. Then the local velocity follows from the simple relation $V_{H_2O} = (1/\tau_1)$. The applied method has proven to be very useful in the determination of local fluid velocities from which velocity profiles and total recirculation flow can be derived. 5 references. (auth)

11118 APPLICATION OF PRESTRESSED REACTOR VESSELS IN NUCLEAR ELECTRIC POWER PLANTS. Grujic, Branimir (Inst. for Material Testing, Belgrade). Tehnika (Belgrade); 24: 1371-80(1969). (In Serbo-Croatian).

Presented is an explanation of nuclear power plant technology and a short review of the nuclear power plants in the world, either already in operation or under construction, which are equipped with prestressed concrete vessels. A number of tables with important data of major importance for the solution of construction problems are included. (auth)

11119 THTR, 300 MW PROTOTYPE NUCLEAR POWER PLANT WITH HIGH TEMPERATURE REACTOR. Schweiger, Fritz. Brennst.-Waerme-Kraft; 21: 583-5(Nov 1969). (In German).

The Thorium High-Temperature Reactor power plant is described, and some technical data on its principal components are discussed. The power plant heat transfer circuit is illustrated. (H.D.R.)

11120 FORECASTING THE URANIUM REQUIREMENTS OF THE US CENTRAL STATION NUCLEAR POWER MARKET. Hogerton, J. F.; Stoller, S. M. (S. M. Stoller Associates, New York). pp 3-12 of Economics of Nuclear Fuels. Vienna; International Atomic Energy Agency (1968).

From Symposium on Economics of Nuclear Fuels, Gottwaldov, Czechoslovakia. See STI/PUB-188; CONF-680541.

Forecasting uranium requirements for a given nuclear power market involves a number of factors that introduce varying degrees of uncertainty into quantitative projections. Among the more obvious are delays in the completion of existing nuclear power projects and/or in reaching target power levels and capacity factors; the rate and pattern of future growth of the nuclear power market; changes in specific inventory and make-up requirements for U resulting from technological advances and/or some changes in economic conditions (e.g., U price); time intervals required for U refining, enrichment, conversion, fabrication, and on-site storage; policies and practices in recycling Pu and U recovered from spent fuel reprocessing; and timing of the introduction of breeders and their characteristics. A projection of the U requirements for the U. S. central station market is developed up to 1980, and an attempt is made to bracket, individually and collectively, the degree of uncertainty introduced by all but the last of the above-mentioned factors. The reason for omitting the last factor is that breeders are not expected to have any significant impact on U. S. uranium demand over the stated period. (auth)

11121 NUCLEAR FUEL CYCLE COST TRENDS UP TO 1980. Bonanni, M. (Westinghouse International Atomic Power Corp., Geneva); Dollard, W. J.; Smith, D. R.; Smith, E. E. pp 13-26 of Economics of Nuclear Fuels. Vienna; International Atomic Energy Agency (1968).

From Symposium on Economics of Nuclear Fuels, Gottwaldov, Czechoslovakia. See STI/PUB-188; CONF-680541.

During the past decade fuel cycle costs for water reactors have dropped by a factor of four. To a large degree this decrease has been due to improvements in fuel design and fuel management techniques. Future improvements in fuel design will have less effect. It is now necessary therefore to concentrate on individual items of the fuel cycle itself for future cost reductions. The cost trends in each of the major components of the nuclear fuel cycle are predicted. Cost trends in uranium procurement and conversion to UF_6 are forecast, and the most recent announcements by the USAEC on cost of separative work are interpreted. Prediction of future fuel fabrication costs is given. As is the case with other chemical operation, the reprocessing cost is extremely sensitive to volume. Additional cost reductions may be available through the use of new reprocessing methods. Pu recycle in thermal reactors is discussed in some detail, and the value of plutonium calculated as a function of the cost of fabrication. The information is summarized by comparing the effect on total fuel cycle cost of the most optimistic fuel cycle cost predictions with the most pessimistic predictions. 8 references. (auth)

11122 IMMEDIATE PROSPECTS FOR THE THORIUM CYCLE. Feinberg, S. M. (Inst. of Atomic Energy, Moscow). pp 27-35 of Economics of Nuclear Fuels. Vienna; International Atomic Energy Agency (1968). (In Russian).

From Symposium on Economics of Nuclear Fuels, Gottwaldov, Czechoslovakia. See STI/PUB-188; CONF-680541.

The rapid growth of nuclear power raises in acute form the problem of securing the necessary raw materials, for it is assumed that natural reserves of cheap nuclear raw materials are limited. Interest is therefore growing in the use of fuel cycles with conversion ratios close to unity. In thermal reactors the conversion ratio can be increased by using a U–Th cycle. This is a possibility often discussed in the literature, but it has been thought that the Th cycle may be economically impracticable in the immediate future. The economics of the U–Th cycle in U–graphite pressure-tube reactors, with pressure tubes, fuel element claddings of Zr alloys, and fuel element cores of sintered dioxides are reviewed. The economic conditions under which the U–Th cycles are comparable with and better than the economics of U–U cycles, are indicated and the reduction of natural U requirements that the use of Th entails are noted. It is argued that the U–Th cycle will prove economically acceptable in the near future. (auth)

11123 URANIUM REQUIREMENTS FOR THE LONG-TERM NUCLEAR POWER GENERATING PROGRAM IN JAPAN. Nagashima, K.; Izumi, T. (Sumitomo Atomic Energy Industries Ltd., Osaka). pp 37-53 of Economics of Nuclear Fuels. Vienna; International Atomic Energy Agency (1968).

From Symposium on Economics of Nuclear Fuels, Gottwaldov, Czechoslovakia. See STI/PUB-188; CONF-680541.

A study of the long-term nuclear electric power generating program has been undertaken. An over-all nuclear electric power generating system is considered in which both fast breeders and thermal reactors would be used. It is also considered that light-water reactors and heavy-water advanced converters will be installed in Japan. The advanced converters are assumed to be commercially developed by the mid-1970s. The fast reactors are assumed to come into the system by 1985. Plutonium to be used in fast breeders will be produced in the system and not purchased from the outside. Three time lags are taken into consideration: the time lag between discharge of plutonium from reactors and its availability for fast breeders; the delay between availability of reactors and start-up of commercial operation; the time between start-up of commercial operation and the first discharge of plutonium from reactors. The generating capacities of fast breeder and thermal reactors have been estimated, and the self-sustaining point has been determined to be the time when

the generating power of the system is supplied by fast breeders alone. The total amount of U_3O_8 necessary for the system has also been determined. 6 references. (auth)

11124 SOME ECONOMIC ASPECTS OF FUEL CYCLES IN THE CSSR. Hulka, I. (Skoda Works, Pilsen, Czech.). pp 55-63 of Economics of Nuclear Fuels. Vienna; International Atomic Energy Agency (1968).

From Symposium on Economics of Nuclear Fuels, Gottwaldov, Czechoslovakia. See STI/PUB-188; CONF-680541.

Domestic reserves in uranium ores and the unfavorable structure of conventional fuel sources in Czechoslovakia make it realistic to envisage the use of uranium to meet the increase in Czechoslovak electric power generation in the near future. In essence, there are two possibilities at present (not considering the economically unfavorable purchase of conventional fuel in exchange for exported uranium) for using uranium reserves for power generation, natural uranium burning, and enriched uranium burning. An attempt is made to compare these possibilities from the point of view of the fuel cycle, based on a given model of a nuclear system for the Czechoslovak needs in the 1970 to 90 period. The enriched uranium fuel cycle considered is for a boiling light-water reactor; in such a case uranium is put through diffusion plants abroad. The use of natural uranium is being studied for the Canadian heavy-water reactor concept; fuel is manufactured by local industry. (For the present, price entrapolations for the Czechoslovak GCHWR would be less exact.) The factors affecting fuel cycle costs under Czechoslovak economic conditions which have been given special attention are raw material and fuel consumption sensitivity to raw material cost changes and the share of total imports. 3 references. (auth)

11125 AVAILABILITY OF PLUTONIUM: ITS INFLUENCE ON LONG-TERM REACTOR PROGRAMS. Scuricini, G. B.; Lavrencic, D.; Valant, P. (CNEN, Rome). pp 65-86 of Economics of Nuclear Fuels. Vienna; International Atomic Energy Agency (1968).

From Symposium on Economics of Nuclear Fuels, Gottwaldov, Czechoslovakia. See STI/PUB-188; CONF-680541.

For a nuclear program involving Pu-fueled fast reactors, it is fundamentally important to determine how much fast reactor power can be installed year by year on the basis of existing Pu supplies. An attempt is made to find a solution that, although mathematically rigorous, can nevertheless be adapted to the particular features of the power grid and the reactors. The principles governing the evolution of power requirements are expressed in terms of an exponential law with progressive saturation. The introduction of different reactor types is assumed to be continuous and uniform, occurring at a rate that is nevertheless subject to control. Figures are given for holdup times (due to various technological operations) and for fuel irradiation times. On the basis of the theoretical work a computer code to study the development of nuclear programs was prepared for use with IBM-7090 digital computers. It was found that the proposed theory allowed a very simple comparison of different programs, in view of the possibility of directly comparing the time constants for the evolution of power production programs in general and nuclear power programs in particular, and the characteristics of various reactor types. Moreover, it is extremely important to be able to determine quickly, in different cases, whether or not the economy is based on plutonium equilibrium. 7 references. (auth)

11126 FUEL COMPONENT OF POWER COSTS AND A CRITERION FOR THE EFFICIENT USE OF NUCLEAR FUEL. Batov, V. V.; Koryakin, Yu. I. (Inst. of Atomic Energy, Moscow). pp 87-98 of Economics of Nuclear Fuels. Vienna; International Atomic Energy Agency (1968). (In Russian).

From Symposium on Economics of Nuclear Fuels, Gottwaldov, Czechoslovakia. See STI/PUB-188; CONF-680541.

The economic efficiency of investment in working capital funds established to cover fuel loadings for nuclear power stations is considered from its methodological aspects, attention being given to the volume of investment required at particular times, and to regular budgetary provisions for nuclear fuel. A general expression is obtained for the fuel component of power costs, and a criterion for the efficient use of nuclear fuel is derived in the light of the conditions mentioned. The method is applied explicitly to various types of reactors and to some special situations (transient conditions, continuous reloading). 2 references. (auth)

11127 SOME ASPECTS OF FUTURE COST TRENDS ON THE RELATIVE ECONOMICS OF BWRs AND BHWRs. Haga, I. (Aktiebolaget Atomenergi, Stockholm). pp 99-111 of Economics of Nuclear Fuels. Vienna; International Atomic Energy Agency (1968).

From Symposium on Economics of Nuclear Fuels, Gottwaldov, Czechoslovakia. See STI/PUB-188; CONF-680541.

The expected future cost development of the different components of fuel cycle costs such as the costs of fabrication, reprocessing, and separative work together with the prices of U and Pu will influence the relative economics of different reactor types. The expected cost trends in most of these parameters favor reactors fueled with natural U compared with reactors for enriched U. A comparison is made of the capitalized fuel cycle costs of a natural U BHWR and a BWR. The calculations are based upon assumed continuous price trends in each of the fuel cost components during a 30-year period. The influence of technological developments as well as the economy of scale are discussed. 7 references. (auth)

11128 ASPECTS OF FUEL SUPPLY AND MANAGEMENT OF SIGNIFICANCE DURING TENDER ASSESSMENT. Knowles, P.; Flood, B. (Merz and McLellan, Newcastle-upon-Tyne, Eng.). pp 115-28 of Economics of Nuclear Fuels. Vienna; International Atomic Energy Agency (1968).

From Symposium on Economics of Nuclear Fuels, Gottwaldov, Czechoslovakia. See STI/PUB-188; CONF-680541.

With the continuing growth of nuclear energy as a power source throughout the world, fuel supply and management have become of great importance both for specialist firms and large utilities handling their own affairs. Some of the alternative problems of fuel supply facing a utility as it prepares to go out to tender for a nuclear station are described. The already large commitment to nuclear power has brought renewed speculation on the ability of both the mining industry and the known deposits of U ore to supply the necessary fuel at the right price. The choice of reactor types is important in this context; the fuel demands of water, advanced gas, high-temperature gas, and heavy-water reactors vary considerably. The effect of a change in ore price on both fuel cycle and generation costs over the life of a station is indicated for different reactor types. Types of guarantee on the fuel cycle are considered and it is suggested that guarantees may well become simpler as utility experience in the nuclear field grows. 6 references. (auth)

11129 DETERMINATION OF LEVELIZED FUEL CYCLE COSTS FOR ALTERNATE FUEL CYCLE OPTIONS. Geiler, L. (S. M. Stoller Associates, New York). pp 129-46 of Economics of Nuclear Fuels. Vienna; International Atomic Energy Agency (1968).

From Symposium on Economics of Nuclear Fuels, Gottwaldov, Czechoslovakia. See STI/PUB-188; CONF-680541.

Techniques in which the present worth of all future revenue requirements over plant lifetime are used to evaluate alternate plant offers may often be modified to advantage when treating the fuel components of those offers because of large future uncertainties in the latter. Those uncertainties, potentially much larger than the discounting implied in the present-worth method, are due to such factors as the market for uranium and plutonium, particularly as they may be affected by escalation; fuel management options available to the different plants and the effect of these on market prices; and plant load factors. Deviations from the straightforward applications of the Present Worth of All Future Revenue Requirements Method, such as reducing the time interval over which the comparison is made, using large discount factors, or using mean and extreme values for each cycle parameter and then weighting results, may be used to advantage. The effects of such modifications and their significance for fuel cycle evaluations are discussed and illustrated by numerical examples. 5 references. (auth)

11130 FACTORS AFFECTING THE ECONOMICS OF THE APPROACH TO EQUILIBRIUM FOR AN AGR FUEL CYCLE. Johnson, A. (United Kingdom Atomic Energy Authority, Risley, Eng.). pp 147-63 of Economics of Nuclear Fuels. Vienna; International Atomic Energy Agency (1968).

From Symposium on Economics of Nuclear Fuels, Gottwaldov, Czechoslovakia. See STI/PUB-188; CONF-680541.

The basic fuel management scheme for an on-load refueled AGR is described, particular consideration being given to its implications to both the fuel supplier and the reactor operator during the approach to equilibrium period. Alternative techniques and calculation methods aimed at minimizing the fuel cycle costs during this period are discussed and illustrated in terms of short-term fuel requirements; such analyses are of considerable use to both the fuel supplier and the reactor operator in optimizing the overall fuel cycle. Possible fuel performance guarantees are discussed in terms of both the fuel supplier's and reactor operator's requirements during the approach to equilibrium. The relative worths to the operator of endurance, burnup, and fuel cycle cost guarantees are considered and illustrated by a comparison of the penalties to which the fuel supplier is liable in the event of a shortfall in fuel performance. 4 references. (auth)

11131 OPTIMIZING DECISIONS IN THE OUT-OF-PILE FUEL CYCLE. Steele, G. (United Kingdom Atomic Energy Authority, Risley, Eng.). pp 165-82 of Economics of Nuclear Fuels. Vienna; International Atomic Energy Agency (1968).

From Symposium on Economics of Nuclear Fuels, Gottwaldov, Czechoslovakia. See STI/PUB-188; CONF-680541.

The optimum installation of facilities to meet the future demand for the supply and reprocessing of oxide fuel, and the operation of these facilities such that the whole complex operates at optimum efficiency are discussed. To achieve this optimization, mathematical models of the various facilities have been constructed and are being integrated into an overall model of the out-of-pile fuel cycle. With the aid of a computer, this model is being used to assess the economic consequences of various capital investment decisions, and will be used to control flows of material in the cycle during actual operations. The mathematical model is described and examples of its use are given. (auth)

11132 COMPARISON BETWEEN ACTUAL AND PRESENT-WORTH METHODS OF FUEL CYCLE COSTING FOR FAST BREEDERS. Gupta, D.; Jansen, P.; Kraemer, R. (Kernforschungszentrum, Karlsruhe, Ger.). pp 183-99 of Economics of Nuclear Fuels. Vienna; International Atomic Energy Agency (1968).

From Symposium on Economics of Nuclear Fuels, Gottwaldov, Czechoslovakia. See STI/PUB-188; CONF-680541.

In principle, two different methods can be used for calculating the fuel cycle costs for fast breeders. In the first method the various cost items accrued for a given amount of fuel over a given period are summed up and divided by the amount of energy produced from the same amount of fuel during the same period of time to obtain specific fuel cycle costs in a specific monetary unit per electrical kilowatt hour produced. In the other method, all the cost items are discounted at a particular time, for example at the starting time of the reactor, and the present worth of all the cost items thus obtained is divided by the energy produced to obtain the specific fuel cycle costs. The first method is somewhat simpler, but less accurate. However, it is possible to analyze the influence of the important cost and reactor parameters with such a costing method. The second method, on the other hand, is highly accurate and is normally used for fuel cycle cost calculations. The two methods are developed and the differences in these methods illustrated with the help of examples. 6 references. (auth)

11133 DOMESTIC AND INTERNATIONAL CAPITAL RESOURCES AND THE NUCLEAR FUEL CYCLE. MacArthur, J. P. (Kleinwort, Benson Ltd., London). pp 201-212 of Economics of Nuclear Fuels. Vienna; International Atomic Energy Agency (1968).

From Symposium on Economics of Nuclear Fuels, Gottwaldov, Czechoslovakia. See STI/PUB-188; CONF-680541.

Nuclear fuel will have an increasing impact on the world energy economy. Its unique qualities distinguish it from other energy sources in terms of trade flows, domestic fuel supplies, and capital. The major distinguishing factors (excluding political and social ones) are the added value and the time scale involved. Major changes in trade flows and methods of financing energy raw material supplies will result. An assessment of the existing and projected size of the total market for nuclear fuel is made in terms of capital employed, to estimate how much capital is and will be tied up at a given time, what currencies are involved, and the balance-of-payments implications. An analysis of the present financing arrangements which reflect different political and marketing ideas and the underdeveloped state of the market, e.g. the U.S. approach, the U.K. approach, the Western European approach is made in an attempt to isolate the true economic cost and highlight distortions in fuel cycle costs resulting from the turnkey contract. Current trends such as moves towards more realistic fuel costing following the commercial breakthrough are reviewed. Familiarity and acceptability helping the market to move towards normal commercial criteria in isolating the individual cost components, including finance are noted. The relative importance of finance is reviewed. A demonstration that the cost of capital is a significant element in total fuel costs is discussed along with the impact on total costs of varying the borrowing terms and rate of interest at different stages in the cycle. Optimum financing methods in several different actual and potential situations are examined and an analysis of the financial techniques available at present together with an outline of those that could be modified or evolved specifically to serve the nuclear cycle are presented. Types of corporate entity in nuclear finance, the suitability of leasing companies, merchanting companies or specialist finance-raising entities compared with ad hoc arrangements are discussed. An assessment of the cost and availability of international capital for nuclear fuel finance compared with domestic capital sources is presented. The influence of the corporate structure and type of contract on access to different financial markets is examined. (auth)

11134 NUCLEAR FUEL MANAGEMENT: ONTARIO HYDRO. Fanjoy, G. R. (Hydroelectric Power Commission of Ontario, Toronto). pp 213-28 of Economics of Nuclear Fuels. Vienna; International Atomic Energy Agency (1968).

From Symposium on Economics of Nuclear Fuels, Gottwaldov, Czechoslovakia. See STI/PUB-188; CONF-680541.

Ontario Hydro is an electrical utility with a committed nuclear program of 2200 MW(e) of heavy-water-moderated and -cooled natural uranium (CANDU) reactors. The purchase, use and disposal of nuclear fuel are discussed including the methods used for each step and the costs incurred. The present methods are detailed and the future evolution predicted. Nuclear fuel management has unique problems, but in general it is simply another commodity among thousands a utility buys requiring a close look at specifications, purchase, use, and disposal to achieve minimum costs. Long-term raw material contracts and short-term contracts for the fabrication services to convert the raw material to finished fuel have been signed. Methods for scheduling the fuel through the reactors are developed from the fuel management work done by the reactor designers. At present the spent fuel is assigned a zero value and stored for future sale or use. All contracts for the first charge fuel for the four-unit, 2000-MW(e) Pickering Generating Station have been signed, and show a total fuel cost of $40.60/kg U (1967 U.S. dollars) for 375 MgU of finished fuel. At equilibrium this results in a fueling cost of 0.63 mills/kWh. Fuel cycles other than the present natural U cycle are now being evaluated. The use of plutonium is receiving most attention to determine whether this plutonium should be sold as spent fuel, reprocessed and sold as nitrate, or recycled. An equilibrium fuel cycle cost of 0.38 mills/kWh is expected in about 1980. 5 references. (auth)

11135 ECONOMICS OF THE NUCLEAR FUEL CYCLE. Yamano, M. (Science and Technology Agency, Tokyo); Tsuzuki, T. pp 229-39 of Economics of Nuclear Fuels. Vienna; International Atomic Energy Agency (1968).

From Symposium on Economics of Nuclear Fuels, Gottwaldov, Czechoslovakia. See STI/PUB-188; CONF-680541.

In evaluating nuclear power economics, the most important problem is to determine the nuclear fuel cycle cost. The method of estimated nuclear fuel cycle cost and the cost trends of the main components of the LWR fuel cycle, which is expected to be the main nuclear power reactor type in Japan in the coming decades, were investigated. The results of these studies are the basis of an evaluation of nuclear fuel cycle costs. In addition, the fuel cycle cost for the case where both nuclear fuel fabrication and spent fuel reprocessing facilities are set up in Japan was studied. These are major components of nuclear fuel cycle costs. The economics of a nuclear power system using the present-worth method, assuming future power generation capacity and also assuming reactor characteristics to be adopted in future power systems were evaluated. The relation between the long-term fuel cycle costs and the characteristics of power reactors in the power system were examined. (auth)

11136 CONCEPTS OF THE ECONOMETRIC MODEL AND EXAMINATION OF ITS RESULTS. Takei, M. (Inst. of Energy Economics, Tokyo). pp 241-60 of Economics of Nuclear Fuels. Vienna; International Atomic Energy Agency (1968).

From Symposium on Economics of Nuclear Fuels, Gottwaldov, Czechoslovakia. See STI/PUB-188; CONF-680541.

Long-range forecasting of nuclear fuel cycle cost requires choosing an optimum nuclear power system by evaluating such factors as power costs, the fuel cycle pattern of each reactor type, the production and accumulation of plutonium, and the performance characteristics of fast breeder reactors. A brief explanation is given of an econometric model concept developed for this purpose, and the results are examined from the point of view that nuclear power in Japan must compete with power produced by other fuels. The optimum condition mentioned above can be determined by means of a parametric study of our econometric model in accordance with the estimate of electricity demand and supply in Japan up to the year 2000. Power production in Japan is expanding and will continue to expand rapidly, and the rapid growth of nuclear power production is therefore expected. Using a comparison with other fuels, a close examination is made of the expanded scale of the nuclear fuel cycle, and its role and general impact on the energy economy as a whole. 4 references. (auth)

11137 ECONOMICS OF PLUTONIUM UTILIZATION IN AN INTEGRATED GENERATING SYSTEM OF THERMAL AND FAST REACTORS. Iliffe, C. E. (United Kingdom Atomic Energy Au-

thority, Risley, Eng.). pp 261-72 of Economics of Nuclear Fuels. Vienna; International Atomic Energy Agency (1968).

From Symposium on Economics of Nuclear Fuels, Gottwaldov, Czechoslovakia. See STI/PUB-188; CONF-680541.

The technique of assessing alternative nuclear power programs on the criterion of present worth of their expenditure is now well-known. An alternative, and sometimes more convenient, way of expressing this criterion is in terms of the concept of system generating cost. This type of assessment has been applied to a national nuclear power program similar to that currently forecast for the United Kingdom. The analysis concentrates on the effect of parameters that can influence the flow of plutonium between thermal and fast reactors. These include: fast reactor breeding ratio and plutonium inventory, plutonium production from thermal reactors, reprocessing losses, timing of introduction of fast reactors, load factor order of merit, and discount rate and length of discounting period. For each variant the fraction due to fast reactors of the present worth of electricity generated by the system has been computed, so that the corresponding change in system generating cost can be expressed in terms of the cost differential between thermal and fast reactors. In this way the economic significance of each of the parameters investigated can be evaluated. (auth)

11138 FUEL CYCLE COST OF GRAPHITE BERYLLIUM OXIDE-MODERATED LARGE PEBBLE-BED REACTORS. Brandes, S. (Brown Boveri/Krupp Reaktorbau GmbH., Mannheim, Ger.). pp 383-97 of Economics of Nuclear Fuels. Vienna; International Atomic Energy Agency (1968).

From Symposium on Economics of Nuclear Fuels, Gottwaldov, Czechoslovakia. See STI/PUB-188; CONF-680541.

The utility of substituting part of the graphite moderator in a large pebble-bed reactor by BeO is discussed. The alteration in neutron balance from the (n,2n) Be reaction and the formation of ^{6}Li is discussed. After a short description of the calculation methods, the results for optimized fuel cycles are given. An installed electric capacity of 10,000 MW has been assumed for the optimization scheme, and large reactors with a power of 1200 MW(e) have also been taken into account. The influence of increasing costs of U_3O_8 and likewise varying costs of BeO are considered. The following fuel cycles are discussed: (1) U-Th fuel cycle with reprocessing, in which there will be a saving in fuel cycle cost by using BeO, the optimum conversion factor is below one, and the assumptions that must be made to reach an economic fuel cycle with a thermal Th breeder (conversion factor one) are described; (2) low-enriched U fuel cycle without reprocessing, in which the influences of BeO on fuel cycle cost and on the enrichment of U in comparison with a pure graphite-moderated fuel cycle are presented. 14 references. (auth)

11139 FUEL CYCLES IN HIGH-TEMPERATURE REACTORS. Schloesser, J. (Brown Boveri/Krupp Reaktorbau GmbH., Mannheim, Ger.). pp 399-412 of Economics of Nuclear Fuels. Vienna; International Atomic Energy Agency (1968).

From Symposium on Economics of Nuclear Fuels, Gottwaldov, Czechoslovakia. See STI/PUB-188; CONF-680541.

A survey of possible fuel cycles for a graphite-moderated gas-cooled high-temperature reactor is presented. Both uranium-thorium and slightly enriched uranium fuel are considered, either in a throw-away or a reprocessed cycle. A detailed analysis of the fuel costs of optimized cycles is given. These cycles are compared, utilizing a pebble-bed reactor and taking into account the limitations imposed by metallurgical considerations such as maximum fuel temperature, maximum surface temperature, and maximum stress. Reference is made to the influence of coated particle size, to fuel cost and to the method of evaluation. The optimization of two fuel cycles (uranium-thorium with reprocessing and slightly enriched uranium without reprocessing) is described, whereby the capital costs are allowed to influence the choice of the fuel cycle parameters. In this context a scheme is discussed and results given whereby the parameters of the fuel cycle analysis—power density, residence time of the fuel element, average ratio of moderator to fissile atoms, degree of heterogeneity—are combined with those parameters determining the capital costs to find the optimum design. The capital cost parameters taken into account are the dimensions of the pressure vessel, the gas inlet and outlet temperatures, and data characterizing the heat-exchanger layout. Thus the capital costs of the concrete pressure vessel, the heat-exchangers, blowers and internal structure are considered. Suitable limitations are imposed to ensure a technically feasible solution. 6 references. (auth)

11140 EVALUATION OF VARIOUS FUEL CYCLES IN HEAVY-WATER-MODERATED CIRENE-TYPE REACTORS. Cardosi, G.; Venditti, P. (CNEN, Rome). pp 413-28 of Economics of Nuclear Fuels. Vienna; International Atomic Energy Agency (1968).

From Symposium on Economics of Nuclear Fuels, Gottwaldov, Czechoslovakia. See STI/PUB-188; CONF-680541.

Fuel cycles in D_2O-moderated and boiling H_2O-cooled pressure tube CIRENE-type reactors are examined. The reference design of 500-MW(e) reactors is determined for optimum efficiency of each fuel cycle. Irradiation level, specific power in the fuel, moderator-to-fuel ratio and active length of the channel are the main parameters assumed in the optimization. The influence of number of rods in the cluster (in the case of 19 and 37 rods) is also examined. The U-Th cycle with the complete recycle of ^{233}U produced in an equilibrium cycle is evaluated, the fuel makeup being ^{235}U fully enriched. An economic evaluation is carried out assuming either an integrated reprocessing plant or a centralized reprocessing plant. In the natural U cycle the Pu recovery and the once-through cycle are analyzed. In the U-Pu cycle the complete recycle of Pu produced in an equilibrium cycle is considered; the enrichment of supplementary fissionable material (^{235}U) is determined in accordance with burnup calculations. The comparison of results shows that the U-Pu cycle is the most advantageous. 11 references. (auth)

11141 ASSESSING THE VALUE OF PLUTONIUM FOR USE IN PRESSURIZED AND BOILING LIGHT-WATER REACTORS. Loizzo, P. (CNEN, Casaccia, Italy). pp 429-60 of Economics of Nuclear Fuels. Vienna; International Atomic Energy Agency (1968).

From Symposium on Economics of Nuclear Fuels, Gottwaldov, Czechoslovakia. See STI/PUB-188; CONF-680541.

The reported value of Pu recycle in light-water reactors ranges from \$7 to \$11/g depending upon the economic assumptions that are made, particularly the economic penalty associated with fabricating Pu fuel elements. An earlier study gives detailed information on the cost of fabricating enriched UO_2 and PuO_2-UO_2 fuel elements for both vibrationally compacted and pelletized fuels in a one ton (oxide) throughput-per-day plant. An extension of this study is described, aimed at improving the value of Pu in H_2O power reactors through reduction of the fabrication cost penalty associated with manufacturing Pu-bearing fuel elements. The fuel cycles of a BWR (Brown's Ferry design) and of a PWR (Burlington design) were evaluated with both UO_2 and PuO_2-UO_2 fuels, and the value of Pu was determined by the indifference method. The hypothesis of direct substitution of mixed oxide rods for the U rods was maintained, and the changes in the value of Pu were obtained by varying such items as Pu enrichment, fuel density, and extra enrichments per fuel assembly. The value of Pu was found to vary asymptotically from \$9 to \$10/g. Reducing the fuel density has little effect on the exposure achieved or the enrichment required, and the Pu value for reduced-density fuel is nearly equal to that of full-density fuel. To achieve the same value of Pu with a reduced-density fuel, the cost of fabricating the fuel must be at least 15% less (at 70% td) than at full density. 12 references. (auth)

11142 VALUE OF PLUTONIUM AS A MAKE-UP FOR THORIUM THERMAL CONVERTERS. Graziani, G.; Rinaldini, C.; Zanantoni, C.; Devos, J. J.; Paruccini, M. (EURATOM, Ispra, Italy). pp 461-81 of Economics of Nuclear Fuels. Vienna; International Atomic Energy Agency (1968).

From Symposium on Economics of Nuclear Fuels, Gottwaldov, Czechoslovakia. See STI/PUB-188; CONF-680541.

Th fuel cycles have been optimized for high-temperature gas-cooled (HTGR) reactors and heavy-water-moderated reactors. Fully enriched ^{235}U and Pu have been considered as makeup alternatives. The full recycle scheme and (with ^{235}U makeup) the segregation scheme have been considered. From the comparison between the fuel cycle costs with ^{235}U and Pu makeup, the value of the latter has been determined. The optimization has been carried out by considering the fuel cycle only, as the remaining part of the energy cost is independent of the type of fuel. The parametric studies were carried out for a set of the following parameters: specific power, burnup, and moderation ratio. For the HTGR reactors, the power density was varied between 5 and 12.5 W/cm^3 core average, the burnup between 20,000 and 120,000 MWd/t of metal, the Ca/Th atomic ratio between 150 and 400. No detailed consideration of the fuel element shape was made, as the degree of heterogeneity is always sufficiently small to be disregarded but for the evaluation of the power peak factor. For the power peak factor a separate assessment has been made with a typical lumping. For the heavy-water-moderated reactors, the results for the pressure-tube, organic-cooled variant (ORGEL) are reported since there is no major effect of the type of the reactor (e.g. type of coolant, pressure tube, or pressure vessel) on the Pu value. For this reactor two types of fuel elements have been considered: SAP-clad-oxide 19- and 37-rod clusters. The

core-average specific power in the fuel was varied between 20 and 50 W/g of fuel, the burnup between 10,000 and 60,000 MWd/t, the moderator/fuel volume ratio between 8 and 18. The evaluation of the fuel cycle and its cost was performed for the continuous charge-discharge fuel management scheme at equilibrium. The cost parameters such as fuel fabrication and reprocessing costs and interest rate were varied to assess the sensitivity of the Pu value to the economic assumptions. The value of fissile Pu discharged from a modern light-water reactor (typical composition: ^{239}Pu = 73%, ^{240}Pu = 15%, ^{241}Pu = 12%) is about $11/g of fissile material for the HTGR reactors and about $13/g of fissile material for the D_2O reactor with the assumptions made here. These values are closed-market values, in the sense that they have been determined for a system where there is only one type of reactor on the market. 9 references. (auth)

11143 ECONOMICS OF PLUTONIUM RECYCLE IN CANADIAN HEAVY-WATER REACTORS. Cohen, R. L.; Pawliw, J.; Penn, W. J. (Canadian General Electric Co. Ltd., Peterborough). pp 483-98 of Economics of Nuclear Fuels. Vienna; International Atomic Energy Agency (1968).

From Symposium on Economics of Nuclear Fuels, Gottwaldov, Czechoslovakia. See STI/PUB-188; CONF-680541.

The Ontario power generation program has 220 MW(e) of nuclear power on line. A further 2000 MW(e) has been committed for operation by 1974. Advance planning by the Ontario utility indicates that at least 500 MW(e) per year will be added in Ontario each year after 1974. The corresponding throughput of natural U will yield 796 kg of Pu per year by 1974, increasing by a minimum of 160 kg of Pu per year thereafter. The predicted costs of processing spent fuel vary from $75/kg U for a ½ tU/d plant to a possible $6/kg for a 10 t/d plant. Cost estimates for the fabrication of low-enrichment Pu fuel in the U. S. for light-water reactors have been in the region of $100/kg excluding the cost of Pu. Estimates recently made in Canada, for volumes of 300,000 lb/yr, show that the price for the fabrication of Pu-bearing fuels for heavy-water reactors may be less than $70/kg, again excluding the cost of Pu. Combining the potentially low reprocessing and fabrication costs makes Pu recycle in heavy-water reactors an economical and desirable goal. As these low costs are only possible with large reprocessing and fabrication plants, Pu recycling will probably not be carried out in Canada until the late 1970s. To ensure maximum utilization of Pu from the resource and investment points of view, both a short-term and a long-term solution are required. In the short-term solution it is presumed that spent fuel will be reprocessed outside Canada and the resulting Pu either sold on the world market or recycled in Canada. Credit thus obtained should result in fueling costs of less than 0.6 mills/kWh. In the long-term solution reprocessing plants will be set up in Canada. If fast-breeder reactors offer a high enough price for the Pu it will be sold in preference to being used for recycle in a heavy-water reactor. However, if the price from the fast-breeder reactors is not high enough then Pu-bearing fuel will be fabricated in Canada, and a family of heavy-water reactors utilizing both natural U and Pu enrichment will be set up. Fueling costs for this family are established in terms of mills/kWh and MWd/t of mined U. 11 references. (auth)

11144 ASSESSMENT OF SHORT FUEL CYCLES FOR FAST REACTORS. Egleme, M.; Debay, W.; Defrenne, G.; Hermans, L.; Waterschoot, A. (Belgonucleaire, Brussels). pp 501-15 of Economics of Nuclear Fuels. Vienna; International Atomic Energy Agency (1968). (In French).

From Symposium on Economics of Nuclear Fuels, Gottwaldov, Czechoslovakia. See STI/PUB-188; CONF-680541.

Analysis of fuel cycle costs for a fast reactor discloses the large proportion of capital charges due to immobilization of fissile materials in the reactor and the fuel cycle. It is impossible to assess the advantages of reducing irradiated fuel cooling times without studying the economic repercussions on the different stages of the fuel cycle, such as conditioning (dismantling and cleaning), transport, reprocessing, and refabrication. When all these factors are taken into account an optimum cooling time can be found. The possible advantage is assessed of a comprehensive unit embodying both the nuclear power plant and the reprocessing and refabrication facilities. The calculations needed for this study were carried out on a data processing machine using the CORCYRE program, which was briefly described at the Symposium on the Use of Plutonium as a Reactor Fuel, held in Brussels in March 1967. The computations were made for the Na-1 (1000 MW(e)) reference reactor studied at Karlsruhe. 10 references. (auth)

11145 EFFECT OF THE REPROCESSING TIME AND THE FUEL THERMAL CONDUCTIVITY INTEGRAL ON THE ECONOMY OF FAST BREEDER REACTORS. Lartigue G., J. (Comision Nacional de Energia Nuclear, Mexico City). pp 517-30 of Economics of Nuclear Fuels. Vienna; International Atomic Energy Agency (1968). (In Spanish).

From Symposium on Economics of Nuclear Fuels, Gottwaldov, Czechoslovakia. See STI/PUB-188; CONF-680541.

It is assumed that fast breeder power reactors that are to be used for industrial purposes must, in addition to generating power cheaply, have a very short fuel doubling time and an extremely low specific inventory. As shown here, however, certain difficulties may arise with regard to the utilization of the Pu produced and the thermal efficiency of the fuel, difficulties that would immediately increase the cost of the Pu produced or the actual doubling time of the system's generating capacity, and that could also cause structural damage to the fuel or a reduction in thermal efficiency. When these problems arise they have, of course, a direct effect on the three requirements already mentioned which reactors of this type must fulfill. As suggested in the literature, these difficulties can be avoided by assigning an optimum specific power; this is achieved when, with constant thermal efficiency, the dwell-time of a fuel load in the reactor is as short as possible, but equal to the reprocessing time. Moreover, if the criterion applied to thermal reactors, requiring maintenance of the maximum possible fuel thermal conductivity integral, is considered to hold good for fast reactors as well, the optimum specific power can be achieved in practice and made to correspond with the maximum value of that integral by varying the design of the fuel element. Thus, the optimum doubling time and optimum specific inventory are defined as those values corresponding to the optimum specific power, and they represent the minimum permissible values for overcoming the difficulties mentioned. To ensure that the minimum values of doubling time and specific inventory permissible in practice are close to the minimum values theoretically possible, it is suggested in general that the thermal efficiency of the fuel should be increased and the reprocessing time reduced. The relevant relationships between the different variables are also worked out for cases mentioned in the literature and for the general case. 22 references. (auth)

11146 ECONOMIC EQUIVALENT VALUES OF URANIUM AND PLUTONIUM ISOTOPES IN FAST REACTORS. Hermans, L.; Egleme, M. (Belgonucleaire, Brussels). pp 531-42 of Economics of Nuclear Fuels. Vienna; International Atomic Energy Agency (1968). (In French).

From Symposium on Economics of Nuclear Fuels, Gottwaldov, Czechoslovakia. See STI/PUB-188; CONF-680541.

The reactivity values of uranium and plutonium isotopes were studied in a paper presented by Baker and Ross at the Argonne Conference in 1964. However, as they stand these values cannot be used in an economic study. A method has been developed of determining economic equivalent values for these isotopes. The technique is based on an economic comparison of various fast reactors loaded with enriched U, Pu or a mixture of the two. Various isotopic compositions of Pu are considered. The calculations were made on a data processing machine using the CORCYRE program, which was briefly described at the Symposium on the Use of Plutonium as a Reactor Fuel, held in Brussels in March 1967. The paper analyzes the effects of certain important parameters on the economic equivalent values. The computations relate to the Na-1 (1000 MW(e)) reference reactor studied at Karlsruhe. 4 references. (auth)

11147 ACTUAL SITUATION AND TRENDS IN THE DEVELOPMENT OF NUCLEAR POWER PLANTS IN THE WORLD. Elektroprivreda; 21: 389-402(Nov 1968). (In Serbo-Croatian).

The development of nuclear power generation in the world is reviewed, pointing out the quality characteristics of nuclear energy as a new source of electric power. The specifications of proved types of reactors in nuclear power plants are listed. The role of breeding reactors in the long term exploitation of nuclear fuels is pointed out. (UKAEA Info. Bulletin)

11148 JOSE CABRERA NUCLEAR POWER STATION CAN GENERATE MORE THAN ONE MILLION MWh ANNUALLY. Luz Fuerza; 28: 9-15(Jan 1969). (In Spanish).

This Spanish station has one Westinghouse pressurized-water reactor fuelled with slightly enriched U oxide, having a 510 MW thermal output. The H-cooled generator is rated at 1.77.5 MVA. The sections of the plant and main design data are considered. (UKAEA Info. Bulletin)

11149 DEVELOPING PROTECTION SYSTEM CRITERIA. Wenzinger, E. C. Power Eng.; 73: No. 11, 34-6(Nov 1969).

Requirements for establishing usable protection system criteria are reviewed. Problems involved in organizing standards are described. (D.C.C.)

11150 BENEFITS VS. RISKS IN NUCLEAR POWER. A LOGICAL, FACTS-AND-FIGURES COMMENT ON THE CURRENT ANTI-ATOM LITERATURE. Jordan, Walter (Oak Ridge National Lab., Tenn.). Oak Ridge Nat. Lab. Rev.: 3: No. 2, 22-30 (Fall 1969).

Some of the controversy over the possible effects of nuclear power plants on the environment and on public health are examined. The risks of nuclear power are compared to hazards inherent in everyday living. The benefits of nuclear power are estimated to far outweigh the risks involved in its use, and the risks of a major nuclear plant disaster are shown to be lower than risks acceptable by many facets of U. S. industry. (H.D.R.)

11151 NUCLEAR POWER AND ENVIRONMENT: AN INQUIRY. Proceedings of Conference Held at Stratton Mountain, Vermont, September 11–12, 1968. Bondville, Vt.; Conservation Society of Southern Vermont (1969). 85p. (CONF-680932).

Papers are presented which discuss the effects of nuclear power plants on the environment. Advantages and disadvantages of nuclear power plants are described. Safeguards and regulations for nuclear power plants are discussed. (D.C.C.)

11152 DIGITAL CONTROL OF THE HALDEN BOILING WATER REACTOR BY A CONCEPT BASED ON MODERN CONTROL THEORY. Bjoerlo, T. J. (OECD Halden Reactor Project, Halden, Norway); Grumbach, R.; Josefsson, R.; Solberg, K. O. Nucl. Sci. Eng.; 39: 231-40(Feb 1970).

The development of a concept for the control of a boiling water reactor by an on-line digital computer is described. The concept is based on the principles of Modern Control Theory. Experimental results are presented which compare digital control and analog control for equivalent perturbations. It appears that the digital control, which uses more process information than the analog control, handles perturbations more effectively. (auth)

11153 WATER COOLANT TECHNOLOGY OF POWER REACTORS. An AEC Monograph. Cohen, Paul. Monograph Series on Nuclear Science and Technology. New York; Gordon and Breach, Science Publishers, Inc. (1969). 450p. $22.00. (TID-25308).

The elements of the scientific and engineering disciplines supporting water technology of high-performance civilian power reactors are presented. Specialized literature of the field is summarized and interpreted. Topics examined under separate sections include: fluid flow, heat and mass transfer; physical chemistry of water and aqueous solutions; radiation chemistry and behavior of gases in reactor systems; radiochemistry and nuclear chemistry of water reactor systems; chemical shim control and pH effect on reactivity; coolant purification and waste disposal; corrosion of reactor materials; and plant contamination. (H.D.R.)

Power Reactor Development

Refer also to abstracts 9987 and 9996.

11154 (BAW–10001) IN-CORE INSTRUMENTATION TEST PROGRAM. (Babcock and Wilcox Co., Lynchburg, Va. Nuclear Power Generation Dept.). Aug 1969. 42p.

In-core flux monitors are used in Babcock and Wilcox-designed central station power reactors to provide power distribution information to confirm physics calculations and to execute a fuel management program. To qualify the all-solid self-powered detector as an in-core monitoring device, B and W initiated several programs to qualify this device for the operating environment of a PWR. These programs included the following features: (1) Determination of the detector's basic physics characteristics. (2) Lifetime tests in a radiation environment. (3) Mechanical integrity tests of the detector and its assembly. Test results are summarized. (auth)

11155 (WASH–1085) EVALUATION OF HIGH-TEMPERATURE GAS-COOLED REACTORS. (Oak Ridge National Lab., Tenn.). Dec 1969. 220p. GPO $2.00.

A review of the 1000 MW(e) high temperature gas cooled reactor designs is presented. Topics discussed include: physics evaluation; engineering evaluation of reactor cores; engineering review of plant design; engineered safety studies; costs; and research and development requirements. (D.C.C.)

11156 MOLTEN-SALT REACTORS: HISTORY, STATUS, AND POTENTIAL. Rosenthal, M. W.; Kasten, P. R.; Briggs, R. B. (Oak Ridge National Lab., Tenn.). Nucl. Appl. Technol.; 8: 107-17(Feb 1970).

Molten-salt breeder reactors (MSBR's) are being developed by the Oak Ridge National Laboratory for generating low-cost power while extending the nations resources of fissionable fuel. The fluid fuel in these reactors, consisting of UF_4 and ThF_4 dissolved in fluorides of beryllium and lithium, is circulated through a reactor core moderated by graphite. Technology developments over the past 20 years have culminated in the successful operation of the 8-MW Molten-Salt Reactor Experiment (MSRE), and have indicated that operation with such type fuel is practical, that the salt is stable under reactor conditions, and that corrosion is very low. Processing of the MSRE fuel has demonstrated the MSR processing associated with high-performance converters. New fuel processing methods under development should permit MSR's to operate as economical breeders. These features, combined with high thermal efficiency (44%) and low primary system pressure, give MSR converters and breeders potentially favorable economic, fuel utilization, and safety characteristics. Further, these reactors can be initially fueled with ^{233}U, ^{235}U, or plutonium. The construction cost of an MSBR power plant is estimated to be about the same as that of light water reactors. This could lend to power costs about 0.5–1.0 mill/kWh less than those for light water reactors. Achievement of economic molten-salt breeder reactors requires the construction and operation of several reactors of increasing size and their associated plants. (auth)

11157 DESIGN AND PERFORMANCE FEATURES OF A SINGLE-FLUID MOLTEN-SALT BREEDER REACTOR. Bettis, E. S.; Robertson, Roy C. (Oak Ridge National Lab., Tenn.). Nucl. Appl. Technol.; 8: 190-207(Feb 1970).

A conceptual design has been made of a single-fluid 1000 MW(e) molten-salt breeder reactor (MSBR) power station based on the capabilities of present technology. The reactor vessel is about 22 ft in diam × 20 ft high and is fabricated of Hastelloy N with graphite as the moderator and reflector. The fuel is ^{233}U carried in a $LiF-BeF_2-ThF_4$ mixture, molten above 930°F. Thorium is converted to ^{233}U in excess of fissile burnup so that bred material is a plant product. The estimated fuel yield is 3.3% per year. The estimated construction cost of the station is comparable to PWR total construction costs. The power production cost, including fuel-cycle and graphite replacement costs, with private utility financing, is estimated to be 0.5 to 1 mill/kWh less than that for present-day light-water reactors, largely due to the low fuel-cycle cost and high plant thermal efficiency. After engineering development of the fuel purification processes and large-scale components, a practical plant similar to the one described appears to be feasible. (auth)

11158 GRAPHITE AND XENON BEHAVIOR AND THEIR INFLUENCE ON MOLTEN-SALT REACTOR DESIGN. Scott, Dunlap; Estherly, W. P. (Oak Ridge National Lab., Tenn.). Nucl. Appl. Technol.; 8: 179-89(Feb 1970).

Existing data on dimensional changes in graphite have been fitted to parabolic temperature-sensitive curves. From these, the graphite life, radiation-induced stresses, and permissible geometries have been calculated. It is concluded existing materials can be utilized in a molten salt reactor which has a core graphite life of about four years, without serious cost penalty. Fission product xenon can be removed by sparging the fuel salt with helium bubbles and removing them after enrichment. With reasonable values of salt-to-bubble transfer coefficient and graphite permeability, the penalty to breeding ratio can be reduced to below 0.5%. (auth)

11159 NEW DEVELOPMENTS IN MATERIALS FOR MOLTEN-SALT REACTORS. McCoy, H. E.; Beatty, R. L.; Cook, W. H.; Gehlbach, R. E.; Kennedy, C. R.; Koger, J. W.; Litman, A. P.; Sessions, C. E.; Weir, J. R. (Oak Ridge National Lab., Tenn.). Nucl. Appl. Technol.; 8: 156-69(Feb 1970).

Operating experience with the Molten-Salt Reactor Experiment (MSRE) has demonstrated the excellent compatibility of the graphite-Hastelloy N-fluoride salt system at 650°C. Several improvements in materials are needed for a molten-salt breeder reactor with a basic plant life of 30 years; specifically, (1) Hastelloy N with improved resistance to embrittlement by thermal neutrons, (2) graphite with better dimensional stability in a fast neutron flux, (3) graphite that is sealed to obtain a surface permeability of less than 10^{-8} cm^2/sec, and (4) a secondary coolant that is inexpensive and has a melting point of about 400°C. A brief description is given of the materials work in progress to satisfy each of these requirements. (auth)

11160 TECHNICAL BASIS OF REACTOR LICENSING. Massera, A. (International Atomic Energy Agency, Vienna). pp 183-6 of Nuclear Law for a Developing World. Vienna, International Atomic Energy Agency, 1969.

See STI/PUB–215.

Safety requirements for licensing of nuclear reactors in the U. S. are described. (D.C.C.)

11161 LICENSING OF NUCLEAR REACTORS IN THE UNITED STATES OF AMERICA. Shapar, H. K. (Atomic Energy Commission, Washington, D. C.). pp 187-96 of Nuclear Law for a Developing World. Vienna, International Atomic Energy Agency, 1969.

See STI/PUB-215.

The development of licensing procedures and requirements for nuclear reactors in the U. S. is reviewed. Present procedures for licensing are described. (D.C.C.)

11162 OUTLINE OF PRELIMINARY DESIGN OF JAPANESE PROTOTYPE FAST BREEDER REACTOR. Miki, Ryohei; Suzuki, Youichi (Power Reactor and Nuclear Fuel Development Corp., Tokyo). Genshiryoku Kogyo; 15: No. 9, 42-8(Sep 1969). (In Japanese).

In the development project of fast breeder reactors in Japan, the design of an experimental reactor was already completed in Power Reactor & Nuclear Fuel Development Corporation, and its construction is now in progress. In the meantime, the preliminary design of a prototype reactor has also been completed by requests to the five atomic-industry groups in Japan. Its criticality is expected in about 1976. The goal of this project is the realization of a commercial FBR of about 1000 MW(e) in the middle of 1980s. The items of the prototype specified by the corporation to the five groups are: electric output, about 300 MW; coolant, liquid Na in the primary and secondary systems, and water-steam in the tertiary system; fuel, mixed plutonium- and uranium-oxide; burn-up, 100,000 MWD/T; maximum cladding temperature, (below) 700°C; breeding ratio, over 1.2; load factor, 80%; life, 30 years. Preliminary designs of the prototype FBR, submitted by the five atomic-industry groups, are described: basic policy underlying the design of the prototype FBR; the preliminary designs (core, reactor construction, cooling systems, steam generators, fuel exchange, instrumentation, etc., and safety and hazard analysis); and research and development, and the extrapolation to the commercial reactor. (NSA of Japan)

Kinetics and Dynamics

11163 (AEEW-M-548) APPLICATION OF THE BINARY CROSS-CORRELATION METHOD FOR DETERMINING FAST REACTOR DYNAMIC RESPONSES. Matthews, J. D.; Smith, D. C. G. (Atomic Energy Establishment, Winfrith (England)). May 1965. 18p. Dep. CFSTI (U. S. Sales Only).

The binary cross-correlation and oscillator methods for obtaining fast reactor dynamic responses are considered and a detailed comparison made between them in terms of equipment, form of output, time taken to obtain results, and perturbation to fuel. (4 references) (auth)

11164 (ANL-7539) ANALYSIS OF THE LINEAR COMPONENTS OF THE POWER-REACTIVITY DECREMENT (PRD) IN EBR-II. Madell, John T.; Jarka, Richard E. (Argonne National Lab., Ill.). Oct 1969. Contract W-31-109-eng-38. 32p. Dep. CFSTI.

The linear components of the power-reactivity decrement (PRD) are described. Their representation for the neutronic calculations is analyzed. The computer processing of the input specifications for the PRD calculations of six loadings of EBR-II is explained, and the results of the calculations are presented. The results indicate that the linear components of the PRD are of the same magnitude for the six loadings. However, small trends in some linear components are observed with changes in core size and substitution of materials in the inner-blanket region. The analytical results compare favorably with the results of the limited amount of experimental data available. The experimental data and recent analytical work suggest that a higher value of the linear-expansion coefficient of the fuel should be used in the PRD calculations. Results of an investigation of partial loss of fuel expansion coefficient and slumping of fuel are presented. 11 references. (auth)

11165 (BAW-3867-9(Vol.1)) FAST BREEDER REACTOR STATIC PHYSICS METHODS DEVELOPMENT AND ANALYSIS PROJECT. VOLUME 1. FARED: ONE-DIMENSIONAL FAST REACTOR PHYSICS DESIGN AND ANALYSIS CODE. Roy, D. H.; Tilford, J. M.; Livolsi, A. Z.; Colpo, P. N.; Carmichael, C. D.; Jacobsen, J. A. (Babcock and Wilcox Co., Lynchburg, Va. Power Generation Div.). Oct 1969. Contract AT(30-1)-3867. 224p. Dep. CFSTI.

The results of a project to formulate, code, and production-test a one-dimensional criticality and depletion code for use in performing rapid and accurate fast breeder reactor physics studies are presented. The basic FARED package comprises two codes. RETAP prepares a microgroup library for use by the cross section averaging and depletion routines. FARED is a one-dimensional static physics design code with an internal cross section collapse program; criticality, depletion, and search routines; fuel management capability; and a variety of edits including an extensive perturbation edit. All input is free format. Volume 1 contains a description of and an operating manual for FARED and RETAP. Volume 2 contains a listing of both codes. Volume 3 contains a listing of the output of the sample test problem. Volume 4 contains the results of various production test and critical experiment studies which were used to test the code and library. (H.D.R.)

11166 (BAW-3867-9(Vol.2)) FAST BREEDER REACTOR STATIC PHYSICS METHODS DEVELOPMENT AND ANALYSIS PROJECT. VOLUME 2. LISTING OF FARED AND RETAP PROGRAMS. Roy, D. H.; Tilford, J. M.; Livolsi, A. Z.; Colpo, P. N.; Carmichael, C. D.; Jacobsen, J. A. (Babcock and Wilcox Co., Lynchburg, Va. Power Generation Div.). Jan 1970. Contract AT(30-1)-3867. 468p. Dep. CFSTI.

11167 (BAW-3867-9(Vol.3)) FAST BREEDER REACTOR STATIC PHYSICS METHODS DEVELOPMENT AND ANALYSIS PROJECT. VOLUME 3. LISTING OF SAMPLE PROBLEM OUTPUT FROM RETAP AND FARED PROGRAMS. Roy, D. H.; Tilford, J. M.; Livolsi, A. Z.; Colpo, P. N.; Carmichael, C. D.; Jacobsen, J. A. (Babcock and Wilcox Co., Lynchburg, Va. Power Generation Div.). Jan 1970. Contract AT(30-1)-3867. 380p. Dep. CFSTI.

11168 (BAW-10010(Pt.1)) STABILITY MARGIN FOR XENON OSCILLATIONS: MODAL ANALYSIS. (Babcock and Wilcox Co., Lynchburg, Va. Nuclear Power Generation Dept.). Aug 1969. 40p.

An analysis of Xe-induced oscillations in large power cores was completed. Axial and azimuthal oscillations were investigated for beginning-of-life, flattened, and slightly dished power distributions. The data were generated for a range of core parameters typical of the current PWR design. The conclusions are: (1) Axial oscillations are possible. (2) Azimuthal oscillations are possible. (3) Radial oscillations will not occur. The modal analysis has shown the importance of the shape of the power distribution in ascertaining stability. Therefore, the continuing Xe analysis program will concentrate on the multidimensional digital calculations. 4 references. (auth)

11169 (BNWL-490) RATIONALE AND PLANS FOR THE FTR CRITICAL EXPERIMENTS PROGRAM. Bennett, R. A.; Hofmann, P. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). 20 Jun 1967. Contract AT(45-1)-1830. 60p. Dep. CFSTI.

A review of the critical experiment programs in MASURCA, SNEAK, ZEBRA, and ZPR-3 assemblies is presented. Uncertainties in design parameters for the FTR are described. The proposed FTR critical experiment program is reviewed. 19 references. (D.C.C.)

11170 (BNWL-1044) GROUP CONSTANTS FOR ANALYSIS OF FFTF CRITICAL EXPERIMENTS. Nelson, J. V.; DeMyer, S. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Nov 1969. Contract AT(45-1)-1830. 24p. Dep. CFSTI.

Nuclear data and multigroup constants are listed which have been available for the analysis of FFTF critical experiments. In general, the cross section data are identical to the 26 group Russian set with the exception that some group constants, for several isotopes, have been modified. Only the data which differ from those previously compiled are included. (4 references) (auth)

11171 (FMRB-14/69) ON-LINE REACTIVITY CALCULATOR. Viehl, E. (Physikalisch-Technische Bundesanstalt, Brunswick (West Germany)). Apr 1969. 19p. (In German). Dep. CFSTI (U. S. Sales Only).

Different circuits of reactivity calculators are described, which can be programmed on usual analog computers. A circuit is shown, which is capable to calculate the single reactivities of a coupled core configuration as well as the total reactivity. 5 references. (auth)

11172 ON THE COMPARISON BETWEEN MODEL AND DIFFERENCE METHOD TO THE ANALYSIS OF THE NEUTRON FLUX DISTRIBUTION. Takahashi, Ryoichi; Hoizumi, Atsushi (Tokyo Inst. of Tech.). Tokyo Kogyo Daigaku Gakuho; No. 90, 39-50(Mar 1969).

In the examination of the burnup of the thermal power reactor, and in the design study of FBR with a special regard to the safety, it is necessary to analyze the two dimensional neutron flux dis-

tribution which is given as a solution of the two dimensional few group diffusion equation. The double series expansion method was used in the case of FBR, and the two methods were examined. The analysis was made by using HITAC 5020. It was concluded that the numerical difference method was more convenient in the more refined calculation of the determinant. The product of the number of the group and expansion terms were much restricted by the core memories of the computer in obtaining the two dimensional neutron flux distribution by the model expansion. (NSA of Japan)

11173 IMPROVEMENTS IN GRAPHITE MODERATORS FOR NUCLEAR REACTORS. Labaton, Vivian Yomtob (to United Kingdom Atomic Energy Authority). British Patent 1,176,685. 7 Jan 1970. Filed 16 Jan 1967.

It has been found that in CO_2-cooled graphite-moderated reactors, where the coolant contains methane as a radiolysis inhibitor, the inhibition factor for a constant methane level is a function of the surface area of the graphite, and the lower the surface area the better the inhibition. In the system described the graphite moderator has a mean surface area of <0.2 sq. m/g (as measured by the BET adsorption technique). Such low surface areas may be attained by repeatedly impregnating the graphite, or carbon from which it is made, with carbonaceous material and carbonizing this material in the graphite pores. Some typical radiolysis results are given. (UK)

11174 ANALYSIS OF A RADIALLY LOADED THERMAL REACTOR. Vigil, J. C.; LaBauve, R. J.; Meem, J. L. (Los Alamos Scientific Lab., N. Mex.). Nucl. Sci. Eng.; 39: 215-25 (Feb 1970).

Transport theory (S_n) calculations of the Ultra High Temperature Reactor Experiment (UHTREX) are compared with results obtained in clean cold critical experiments. These experiments are characterized by a high (43% of all neutrons produced) fast neutron leakage from the core, a hardened thermal neutron spectrum (a reactivity effect of −9.5% compared to a Maxwellian spectrum at the same temperature) and two spatial self-shielding effects. The smaller of the self-shielding effects, −2% in reactivity, occurs in the coated fuel particles contained in the fuel elements. A larger spatial self-shielding effect, −3.6% in reactivity, results from the heterogeneous arrangement of fuel elements and core moderator. The radial fuel channel design and radially graduated fuel loading complicate the calculation of the fuel element self-shielding because the entire core cannot be represented by one simple unit cell. However, conventional cell homogenization techniques are adequate when applied to subregions of the core. In spite of the geometrical complexities, the calculated multiplication factors and fission distributions agree well with experiment. 15 references. (auth)

Control Systems

11175 NUCLEAR POWER PLANT. Kaipainen, Arto; Rullgard, Ake; Skygge, Carl Gosta; Sundqvist, Cnut (to Allmanna Svenska Elektriska Aktiebolaget). British Patent 1,173,800. 10 Dec 1969. Priority date 7 Apr 1966, Sweden.

REACTOR CONTROL SYSTEMS—design parameters for boiling power reactor, with load actuated rapid opening water supply valves
REACTORS, BOILING—control system for power, description of with load actuated rapid opening water supply valves
REACTORS, POWER—control system for boiling, with load actuated rapid opening water supply valves (D.C.C.)

11176 NUCLEAR REACTOR CONTROL USING NEUTRON ABSORPTION FLUID. (to Canadian General Electric Co. Ltd.). British Patent 1,173,813. 10 Dec 1969. Priority date 6 May 1966, Canada.

BORON HYDRIDES—control elements of gaseous, description of pressurized liquid cooled and moderated reactor
HELIUM ISOTOPES He-3—control elements of gaseous, description of pressurized liquid cooled and moderated reactor
KRYPTON—control elements of gaseous, description of pressurized liquid cooled and moderated reactor
REACTOR CONTROL ELEMENTS—design parameters for pressurized liquid cooled and moderated gaseous boron hydride, helium-3, krypton, or xenon-135
XENON ISOTOPES Xe-135—control elements of gaseous, description of pressurized liquid cooled and moderated reactor (D.C.C.)

11177 POLYWATER AS THE MECHANISM FOR THE pH-REACTIVITY EFFECT IN PRESSURIZED WATER REACTORS. D'Ardenne, Walter H. (Pennsylvania State Univ., University Park). Nucl. Sci. Eng.; 39: 272-3(Feb 1970).

An anomalous form of water with properties very different from those of ordinary water has been reported previously. The possibility that such polywater molecules are formed in PWR coolant at high pH values and, because of the higher density of the polywater, cause changes in reactivity is examined. 5 references. (H.D.R.)

11178 CONTROL SYSTEM FOR A NUCLEAR REACTOR PLANT. Fishman, Ygal (to Sulzer Brothers Ltd.). British Patent 1,173,730. 10 Dec 1969. Priority date 14 Dec 1967, Switzerland.

REACTOR CONTROL SYSTEMS—design parameters of gas cooled reactor with coolant temperature actuation
REACTORS, GAS-COOLED—control system for, description of coolant temperature actuated (D.C.C.)

Cooling Systems

Refer also to abstracts 9431 and 9727.

11179 (CEA-R-3915) THE CODE EDITH: CALCULATION OF THE DYNAMIC AND THERMAL CHARACTERISTICS OF A GAS CIRCUIT IN VARIABLE FLOW CONDITIONS. APPLICATION TO THE STUDY OF THE START-UP OF A REACTOR UNDER NATURAL CONVECTION FLOW CONDITIONS. Rosseau, Jean-Claude; Dobremelle, Michel (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Dec 1969. 30p. (In French). Dep. CFSTI (U. S. Sales Only).

The momentum equations for the conservation of mass and energy are applied to a closed circuit in which flows a gas, and which includes energy generators, piping, heat exchangers and blower equipment. The computer code "EDITH" makes it possible to obtain, for any point in the circuit, the gas pressure and temperature, together with the wall temperature, as a function of variations in, for example, the power of the generators, the turbo-blower conditions and the exchangers operational conditions. This code can be applied to the determination of the behavior of a nuclear reactor of the natural U−graphite−gas type. In this reactor the heat exchangers are situated underneath the core which becomes an energy generator if the turbo-blowers stop accidentally. The calculation makes it possible to predict instabilities and flow reversals in the circuit which can adversely affect the proper cooling of the reactor. (auth)

11180 FLUID-COOLED NUCLEAR REACTORS. Appleby, John Rand; Foden, Roy William; Simpkin, Sidney David (to Nuclear Design and Construction, Ltd.). British Patent 1,172,110. 26 Nov 1969. Filed 30 Nov 1967.

A method of reactor operation is described by which the control parameters of the coolant circuit are varied in dependence on power changes in such a manner that the dimensional changes of the canning are substantially matched with the dimensional changes of the fuel. In this way plastic stretching of the canning is avoided. Application is described to an advanced gas-cooled reactor, utilizing UO_2 pellets in stainless steel cans. Typically the temperature of the reactor coolant circuit may be varied by adjusting the outlet gas temperature within the range 2° to 8°C for each 1% variation in power output over the range 75% to 100% total power output. (UK)

11181 NUCLEAR POWER PLANT WITH CO_2 COOLING. (to Siemens Aktiengesellschaft). British Patent 1,177,467. 14 Jan 1970. Priority date 29 Sep 1967, Germany.

HEAT EXCHANGERS—design parameters for carbon dioxide cooled power reactor regenerative
REACTORS, GAS-COOLED—cooling system for carbon dioxide cooled power, description of regenerative heat exchanger
REACTORS, POWER—cooling system for carbon dioxide cooled, description of regenerative heat exchanger (D.C.C.)

11182 IMPROVEMENTS IN OR RELATING TO A GAS COOLED NUCLEAR REACTOR. (to Gesellschaft fuer Kernforschung mbH). British Patent 1,177,498. 14 Jan 1970. Priority date 23 Mar 1966, Germany.

HEAT TRANSFER SYSTEMS—valves for gas cooled reactor, description of quick release non-return
REACTORS, GAS-COOLED—cooling system of, description of quick release non-return valves for
VALVES—design parameters of quick release non-return, for gas cooled reactor cooling systems (D.C.C.)

11183 COLD TRAP FILTER. Cochran, John T.; Collins, G. D. (to United States Atomic Energy Commission). U. S. Patent 3,483,980. 16 Dec 1969.

Cold traps for removing sodium oxide from liquid sodium used as a coolant for a nuclear reactor are described. Sodium oxide is caused to crystallize upon screens which operate as valves or cause a valve to operate letting sodium bypass the clogged screen. In one embodiment, the screen flexes when it becomes clogged to spall or shake off sodium oxide crystals, thereby affording a self-cleaning action. (AEC)

11184 COOLANT MIXING IN REACTOR HEAT TRANSFER. Quaiyum, M. A. Nucleus (Lahore); 6: 82-7(Apr-Jun 1969).

The subject of mixing is introduced and a literature survey is made. The importance of coolant mixing in reactor heat transfer is also explained. Specific suggestions are made for conducting mixing experiments. 18 references. (auth)

Fuels

Refer also to abstracts 9613, 10145, 10150, and 11288.

11185 (ANL-7552) STUDIES OF FAST REACTOR FUEL ELEMENT BEHAVIOR UNDER TRANSIENT HEATING TO FAILURE. III. IN-PILE EXPERIMENTS ON IRRADIATED UO_2 FUEL PINS IN THE ABSENCE OF COOLANT. Stewart, R. R.; Dickerman, C. E.; Robinson, L. E.; Doe, W. B. (Argonne National Lab., Ill.). Mar 1969. Contract W-31-109-eng-38. 30p. Dep. CFSTI.

Studies of the behavior of stainless steel-clad uranium oxide fast-reactor type fuel pins under accident-simulating temperature excursions are under way in the TREAT reactor. Experiments on five preirradiated gas-bonded UO_2 pins are discussed. The pins were tested in TREAT inside transparent capsules to permit recording of events by high-speed color photography. Fast-response thermocouples provided cladding surface-temperature data. These pins had been previously irradiated to a maximum of 6 a/o nominal burnup, at an initial power density of 2.5 kW/cc, producing initial fuel centerline and surface temperatures of 2400 and 1215°C respectively. One pin was heated to a temperature just below that of cladding failure due to melting. Experiments on two other pins produced maximum fuel temperatures equal to the oxide melting point and resulted in severe cladding failure. Two pins were heated to temperatures in the intermediate range between these two extremes. In theory, fission gases are capable of producing rapid fuel motion or even explosive fuel disassembly under transient heating. However, no fuel motions of these types were observed. 35 references. (auth)

11186 (ANL-7597) SURVEILLANCE OF EBR-II BLANKET SUBASSEMBLIES. Eschen, V. G. (Argonne National Lab., Ill.). Sep 1969. Contract W-31-109-eng-38. 31p. Dep. CFSTI.

Examinations performed on unalloyed, depleted-uranium blanket elements from EBR-II are presented. The criteria used in arriving at the present burnup limit of 0.27 at.% (max) are discussed and shown to be conservatively established. Swelling rates were investigated by calculating R values (ratios of swelling percentage to burnup percentage); the minimum and maximum values of R calculated for the points of highest burnup were 63 and 148. A maximum cladding strain of 0.9% was indicated at 0.27 at.% (max) burnup. Specific recommendations are presented for more fully evaluating the irradiation behavior and improving the performance of the blanket elements. A program to evaluate the feasibility of increasing the burnup limit of the present blanket material is proposed. 6 references. (auth)

11187 (BAW-10014) ANALYSIS OF SUSTAINED DEPARTURE FROM NUCLEATE BOILING OPERATION. (Babcock and Wilcox Co., Lynchburg, Va. Nuclear Power Generation Dept.). Aug 1969. 24p.

A pressurized water reactor fuel rod was analyzed for sustained operation at a departure from nucleate boiling (DNB) condition. The analysis was performed for a core power of 2568 MW(t) with an assumed abnormal flow condition (a flow blockage) which would cause a DNB. Operation at the postulated conditions would result in a maximum fuel rod cladding surface temperature of 1111°F and a maximum fuel temperature below the melting point for UO_2. The maximum cladding surface temperature is low enough to prevent a rapid corrosion reaction or a strength reduction sufficient to cause the cladding to burst due to internal pressure. Therefore, no rapid energy releases due to chemical reactions or pressure loadings should occur. However, long-term operation at the assumed conditions could result in a gradual deterioration of the cladding because of corrosion in the steam atmosphere. The absence of rapid energy releases and the presence of good thermal-hydraulic conditions in channels adjacent to the channel with the fuel rod in a DNB condition indicate that DNB propagation and resultant failure of large numbers of fuel rods are highly unlikely. 14 references. (auth)

11188 (LA-4321) GROOVED MELT WIRES FOR TEMPERATURE MEASUREMENT OF REACTOR FUEL. Salgado, P. G.; Thamer, B. J.; Rudman, R. L. (Los Alamos Scientific Lab., N. Mex.). Aug 1969. Contract W-7405-eng-36. 11p. Dep. CFSTI.

The Ultra High Temperature Reactor Experiment (UHTREX) is being conducted at the Los Alamos Scientific Laboratory as a part of the AEC gas-cooled reactor program. One of the features of the reactor is the ability to refuel while operating at full power, accomplished in part by rotating the central core of the reactor. The already difficult job of measuring fuel temperature is thus made even more difficult because connecting tubes or wires cannot be used. As a means for measuring temperatures in UHTREX, certain fuel elements have been examined after test to see which of an implanted array of melt wires have melted, thus determining the temperatures within limits at various locations. Recent work at the Los Alamos Scientific Laboratory has developed grooved melt wires of a variety of compositions covering the temperature range of 275 to 3000°F. Melting can be determined easily and with good precision by radiographing the exposed fuel element or by removing the melt wires and examining them visually. 5 references. (auth)

11189 (ORNL-TM-2448) AN ESTIMATE OF THE ENHANCEMENT OF FISSION PRODUCT RELEASE FROM MOLTEN FUEL BY THERMALLY INDUCED INTERNAL CIRCULATION. Fontana, M. H. (Oak Ridge National Lab., Tenn.). Dec 1969. Contract W-7405-eng-26. 31p. Dep. CFSTI.

An approximate evaluation is presented of diffusion and internal convection as mass transfer mechanisms under fairly quiescent conditions. This condition was chosen because it would result in larger amounts of heat generating fission products remaining in the melt than would be the case with more violent agitation. Internal heat generation in a molten slab of fluid cooled primarily from the upper surface would create a temperature gradient which, at some critical value, would cause internal convection currents due to the greater buoyancy of the hotter material in the lower portions of the melt. These convection currents enhance both the heat and mass transfer from the interior of the molten material to the surface. The heat transfer and rate of release of fission products from a slab of molten fuel and steel were calculated and the results compared with a diffusion calculation. A sensitivity analysis was performed and the effects of wide variations in the thickness of the melt, viscosity, coefficient of thermal expansion, diffusion coefficient, specific heat, and thermal conductivity are presented. For the base case of Y_2O_3 in 200 tons of molten UO_2 and steel in a slab 17.1 cm thick, the time required to release 80% of the fission product was 9 hours, compared with 40 days for the case where a diffusion model was assumed. Although these results are very approximate, being based on estimated thermophysical properties and idealized assumptions, they show that the effect of internal convection on mass transfer is so important that it cannot be ignored in any process where its occurrence may be suspected. 14 references. (auth)

11190 (WAPD-TM-757) A PROCEDURE FOR CALCULATION OF STEADY-STATE TEMPERATURE IN ZIRCALOY-CLAD, BULK-OXIDE FUEL ELEMENTS USING THE FIGRO COMPUTER PROGRAM (LWBR DEVELOPMENT PROGRAM). Goldberg, I. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Nov 1969. Contract AT-11-1-GEN-14. 54p. Dep. CFSTI.

Procedures are specified for using the FIGRO computer program to calculate clad and fuel temperatures in Zircaloy-clad bulk-oxide fuel rods. Rod temperature distributions are calculated at specified depletions from input values of surface heat flux, coolant temperature and pressure, heat transfer coefficients, temperature-dependent clad thermal conductivity, temperature-dependent and concentration-dependent gas thermal conductivity in the fuel-clad gap, and temperature-, depletion-, and porosity-dependent fuel thermal conductivity. Provision is made to account for temperature increases due to long-time crud and corrosion film buildup and steam properties are utilized to compute gap conductance in a defected fuel element. Gap dimensions are adjusted to account for differential thermal expansion and fuel swelling. All major assumptions and analytical procedures are identified. Material property inputs are specified on both a best estimate and design (worst-case) basis. These procedures were developed as part of the LWBR development program. (21 references) (auth)

11191 NEUTRONIC REACTOR WITH NATURAL CIRCULATION OF FLUID FUEL. Geist, J. J. (to United States Atomic Energy Commission). U. S. Patent 3,486,977. 30 Dec 1969.

A neutronic reactor design is provided in which fluid fuel is disposed in vertically extending fuel channels which pass through the active core region. Each vertically extending fuel channel communicates through channels at its upper and lower ends with the respective upper and lower ends of at least one other fuel channel having a different heat source load factor so as to form closed loops positioned wholly within the active region of the reactor core. Natural circulation of the fluid fuel occurs within the closed loops as a result of the dissimilar heat source load factors characterizing the fuel channels in each closed loop. (AEC)

11192 NUCLEAR REACTOR FUELLING ARRANGEMENTS. (to Canadian General Electric Co. Ltd.). British Patent 1,174,253. 17 Dec 1969. Priority date 20 Nov 1965, Canada.

REACTOR LOADING MACHINES—design parameters of liquid cooled, for liquid moderated pressure tube type reactors
REACTORS, HEAVY WATER MODERATED—loading machines for pressure tube type, design parameters of liquid cooled
REACTORS, WATER MODERATED—loading machines for pressure tube type, design parameters of liquid cooled (D.C.C.)

11193 DUCT FOR A NUCLEAR REACTOR. Dufresne, Jacques; Farfalett-Casali, Flaviano; Henry, Bernard (to European Atomic Energy Community). British Patent 1,174,201. 17 Dec 1969. Priority date 13 Dec 1966, Italy.

REACTOR FUEL ELEMENTS—assemblies of, description of pressure tube type, arranged symmetrically in cylinder shaped ducts (D.C.C.)

11194 STATIC AEROELASTICITY OF DISTANCING GRIDS FOR NUCLEAR REACTOR FUEL ELEMENT ASSEMBLIES. PART II. EXPERIMENTS. Kuzelka, Vaclav (National Research Inst. of Machines, Bechovice, Czech.). Jad. Energ.; 15: 290-4(Sep 1969). (In Czech).

Results of the experimental determination of the static aeroelasticity in a grid model are presented. The stress-measurements have been made up in a pressurized gas-flow by means of the resistance strain gauge techniques. The experimental results of aerodynamic characteristics and influence coefficients in the model are given. The experimental values are discussed and the correlation with theory is carried out. The agreement between the theory and experimental results is reasonably good. 7 references. (auth)

11195 PRESSURE MEASUREMENTS IN MODEL FUEL BUNDLES FOR FAST BREEDER REACTOR. Hamid, M. A.; Quaiyum, M. A. Nucleus (Lahore); 6: 77-81(Apr-Jun 1969).

Friction factors and spacer drag-coefficients for flow parallel to rod bundles with spiral spacers have been determined experimentally. Three rod bundles were tested. In all cases, rods were on equilateral triangular lattices. The rod diameter was the same in all the bundles but the diameter of the spacer wires as well as the mode of wrapping was different in each case. Results have been presented in graphical forms and compared with published data. 8 references. (auth)

11196 A STEAM-COOLED NUCLEAR REACTOR, ESPECIALLY OF THE EPITHERMAL OR OF THE FAST TYPE. Bogaardt, Maarten (to Reactor Centrum Nederland). British Patent 1,174,796. 17 Dec 1969. Priority date 31 Mar 1966, Netherlands.

REACTORS, FAST—core for steam cooled, design parameters of
REACTORS, INTERMEDIATE—core for steam cooled, design parameters of
REACTORS, SUPERHEATING—core for epithermal or fast, design parameters of (D.C.C.)

11197 BOILING BURNOUT IN REACTOR. Zenkevich, B. A.; Kozlov, V. Ya.; Kochetkov, L. A.; Peskov, O. L. At. Energ. (USSR); 27: 391-6(Nov 1969). (In Russian).

The experiments on boiling burnout in the nuclear reactor are described. The boiling burnout was achieved on the surface of the tubular fuel element (of 8.2 mm JD and 1700 mm long) mounted in a specific channel into which the water was pumped by centrifugal pump. For fixing boiling burnout, thermocouples were mounted on the outside of the fuel element: six thermocouples in 100 mm from the fuel element output end and two thermocouples in the middle of the fuel element. The experiments were carried out at pressures of 118 and 137 bar and mass velocities of 1500, 2000 and 2500 $kg/m^2 \cdot sec$. The water was fed at the temperature of 290 to 310°C. The boiling burnout was achieved by increasing reactor power at constant pressure and mass velocity. The table with the results of in- and out-reactor experiments shows that the difference between the burnout powers is within the limits of precision of the experiments. The coincidence of the experimental data obtained in and out of reactor confirms the validity of performing experiments on units outside reactor and applying these experimental results for heat removal calculation in tubular fuel elements of nuclear reactors. 4 references. (auth)

11198 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Hilton, Raymond Kenneth (to United Kingdom Atomic Energy Authority). British Patent 1,176,646. 7 Jan 1970. Filed 6 Apr 1966.

A problem arising in power reactors, and particularly in fast reactors operating at high power densities, is the adverse effect of a power surge. Such surges may result in differential thermal expansion of core components and cause fuel assemblies to distort so as to give rise to involved bowing. This in turn may cause a surge in reactivity, and power transients may occur so rapidly that fuel melting occurs. In the system described the fuel element support means includes materials having different thermal expansion coefficients, distortion of the support means deflecting the fuel elements in a manner so as to decrease core reactivity. (UK)

11199 ENGINEERING DEVELOPMENT OF THE MSBR FUEL RECYCLE. Whatley, M. E.; McNeese, L. E.; Carter, W. L.; Ferris, L. M.; Nicholson, E. L. (Oak Ridge National Lab., Tenn.). Nucl. Appl. Technol.; 8: 170-8(Feb 1970).

The molten salt breeder reactor being developed at ORNL requires continuous chemical processing of the fuel salt, $^{7}LiF-BeF_2-ThF_4$ (72-16-12 mole %) containing about 0.3 mole % $^{233}UF_4$. The reactor and the processing plant are planned as an integral system. The main functions of the processing plant will be to isolate ^{233}Pa from the neutron flux and to remove the rare earth fission products. The processing method being developed involves the selective chemical reduction of the various components into liquid bismuth solutions at about 600°C, utilizing multistage counter-current extraction. Protactinium, which is easily separated from uranium, thorium, and the rare earths, would be trapped in the salt phase in a storage tank located between two extraction contactors and allowed to decay to ^{233}U. Rare earths would be separated from thorium by a similar reductive extraction method; however, this operation will not be as simple as the protactinium isolation step because the rare-earth-thorium separation factors are only 1.3 to 3.5. The proposed process would employ electrolytic cells to simultaneously introduce reductant into the bismuth phase at the cathode and to return extracted materials to the salt phase at the anode. The practicability of the reductive extraction process depends on the successful development of salt-metal contractors, electrolytic cells, and suitable materials of construction. (auth)

Auxiliary and Emergency Systems

11200 (JPRS-49481) PRESTRESSED REINFORCED CONCRETE IN CONSTRUCTION OF NUCLEAR INSTALLATIONS. Komarovskii, A. N. Translation of Predvaritel'no Napryazhennyi Zhelezobeton v Stroitel'stve Yadernykh Ustanovok, Atomizdat, Moscow, 1968. 156p. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 23: 21474.

Operation and Economics

11201 (BMwF-FBK-69-27) UNIFORM PROCEDURE FOR CALCULATING FUEL INVENTORIES AND CONSUMPTION RATES OF MAJOR POWER STATIONS SYSTEMS. Faber, C.; Gebhardt, W.; Goetze, S.; Joest, K. H.; Lahner, K.; Lieberoth, J.; Memmert, G.; Sperber, F.; Wellmann, H. (Internationale Atomreaktorbau G.m.b.H., Bensberg (West Germany)). Aug 1969. 153p. (In German). Dep. CFSTI (U. S. Sales Only).

With the object of generating basic details for considerations on the future development of nuclear power station systems for a specific selection of reactors of the leading types, cost-determining factors are computed based on uniform methods and identical nuclear data. The reactors considered include a pressurized-water reactor, a thorium high-temperature reactor (THTR), a fast breeder and converter reactor, and a heavy-water reactor. Cost-determining factors comprise in particular the fuel inventories, as well as consumption and production rates for artificial and

material fission isotopes. The assumption is made that each reactor type considered will be in leading equilibrium, when the fissile materials bred can be fully recycled into the reactor concerned. (auth)

11202 (GA-9797) 40-MW(E) PROTOTYPE HIGH-TEMPERATURE GAS-COOLED REACTOR. POSTCONSTRUCTION RESEARCH AND DEVELOPMENT PROGRAM. Quarterly Progress Report for the Period Ending October 31, 1969. (Gulf General Atomic, Inc., San Diego, Calif.). 26 Nov 1969. Contract AT(04-3)-314. 49p. Dep. CFSTI.

BORON SYSTEMS—B-graphite-radiation effects on dimensional changes in control elements of, measurement of fast neutrons
GRAPHITE SYSTEMS—B-graphite-radiation effects on dimensional changes in control elements of, measurement of fast neutrons
KRYPTON ISOTOPES Kr-85—content in Peach Bottom Power Reactor Unit 1 coolant, effects of power level on
KRYPTON ISOTOPES Kr-87—content in Peach Bottom Power Reactor Unit 1 coolant, effects of power level on
KRYPTON ISOTOPE Kr-88—content in Peach Bottom Power Reactor Unit 1 coolant, effects of power level on
KRYPTON ISOTOPES Kr-89—content in Peach Bottom Power Reactor Unit 1 coolant, effects of power level on
NEUTRONS, FAST—effects on mechanical properties of Peach Bottom Power Reactor Unit 1 fuel elements
—effects on dimensional changes in Peach Bottom Power Reactor Unit 1 boronated graphite control elements
PEACH BOTTOM POWER REACTOR, UNIT 1—operations during August to October 1969
—physics measurements during August to October 1969
—fuel elements of, fast neutron radiation effects on mechanical properties of
—control elements of, fast neutron radiation effects on dimensional changes in
REACTIVITY—measurement of Peach Bottom Power Reactor Unit 1 during August to October 1969
REACTOR CONTROL ELEMENTS—radiation effects on dimensional changes in Peach Bottom Power Reactor Unit 1 boronated graphite, measurement of fast neutron
REACTOR FUEL ELEMENTS—radiation effects on mechanical properties of Peach Bottom Power Reactor Unit 1, measurement of fast neutron
XENON ISOTOPES Xe-133—content in Peach Bottom Power Reactor Unit 1 coolant, effects of power level on
XENON ISOTOPES Xe-135—content in Peach Bottom Power Reactor Unit 1 coolant, effects of power level on
XENON ISOTOPES Xe-138—content in Peach Bottom Power Reactor Unit 1 coolant, effects of power level on (D.C.C.)

11203 (LA-4330) QUARTERLY STATUS REPORT ON ULTRA HIGH TEMPERATURE REACTOR EXPERIMENT (UHTREX) FOR PERIOD ENDING OCTOBER 31, 1969. (Los Alamos Scientific Lab., N. Mex.). 12 Dec 1969. Contract W-7405-eng-36. 12p. Dep. CFSTI.

Operations and maintenance requirements are described for August to October 1969. Radiation test programs are reviewed. Physics measurements are presented. 4 references. (D.C.C.)

11204 REACTOR PHYSICS AND FUEL-CYCLE ANALYSES. Perry, A. M.; Bauman, H. F. (Oak Ridge National Lab., Tenn.). Nucl. Appl. Technol.; 8: 208-26(Feb 1970).

As presently conceived at the Oak Ridge National Laboratory, the single-fluid Molten Salt Breeder Reactor, operating on the $^{232}Th-^{233}U$ fuel cycle and based on a reference design, has a breeding ratio of about 1.06, specific fissile inventory of 1.5 kg/MW(e), a fuel doubling time of about 20 years, and fuel cycle costs of about 0.7 mill/kWh(e). Startup may be accomplished with either enriched uranium or plutonium, with little effect on fuel cost; the breeding ratio, averaged over reactor life, is reduced 0.01–0.02 relative to the equilibrium cycle. Operated as a converter, with limited chemical processing, the reactor may have a conversion ratio in the range 0.8 to 0.9 with fuel cycle costs of 0.7–0.9 mill/kWh(e). (auth)

11205 INTEGRATED NUCLEAR POWER PLANT AND ITS SIGNIFICANCE FOR THE IRONWORKS INDUSTRY. Wenzel, Werner (Institut fuer Eisenhuettenwesen, Aachen); Wingen, Erhard; Franke, Friedrich H. VDI (Ver. Deut. Ing.) Z.; 111: 1473-8(Nov 1969). (In German).

A single conventional ironworks cannot use up the electrical energy of an integrated nuclear power plant having economical dimensions. Though several ironworks, which are situated in a spatial vicinity against each other, could be in a position to do so, it does not seem possible to realize such a compound arrangement, as for instance, in the Ruhr area on account of the existing juristic conditions (rights of way, current delivery contracts). The integrated nuclear power plant, however, is excellently suited to supply with cheap energy newly erected industrial combines which, for instance, may consist of ironworks, chemical plants, and other energy consuming production plants. (auth)

11206 BENEFITS AND COSTS OF DEVELOPING ADVANCED NUCLEAR POWER REACTORS. Vernon, John M. (Duke Univ., Durham, N. C.). Appl. Econ.; 1: 1-16(Jan 1969).

Benefits to be gained from the U. S. Atomic Energy Commission program for the development of advanced converter power reactors are defined. These benefits are taken to be the cost saving in the production of electricity. A selection of a social discount rate and the treatment of development risks are discussed. The program costs are estimated, and results of a cost-benefits comparison are presented. 14 references (H.D.R.)

11207 EXPERIENCE WITH THE MOLTEN-SALT REACTOR EXPERIMENT. Haubenreich, Paul N.; Engel, J. R. (Oak Ridge National Lab., Tenn.). Nucl. Appl. Technol.; 8: 118-36(Feb 1970).

The design and operational characteristics of the MSRE and its associated facilities are summarized. A history of MSRE operation and testing is presented. The experience obtained in the areas of fuel chemistry, materials compatibility, chemical processing, reactivity behavior, dynamics, equipment performance, containment, and maintenance of radioactive systems is described. (H.D.R.)

Safety and Siting

Refer also to abstracts 9435, 11185, and 11305.

11208 (BNL-14242) BEHAVIOR AND TRAPPING OF FISSION PRODUCTS IN PRIMARY REACTOR CIRCUITS AND IN CONFINEMENT VESSELS OF FAST NEUTRON REACTORS. Castleman, A. W. Jr. (Brookhaven National Lab., Upton, N. Y.). Dec 1969. 19p. (CONF-691104-2). Dep. CFSTI.

From International Congress on the Diffusion of Fission Products, Saclay, France.

Experimental work related to fission product behavior in liquid Na systems, trapping of fission products, and behavior of the aerosols of nuclear materials is reviewed. Characteristics of equilibrium vaporization of fission products from liquid Na coolant are analyzed. Vaporization curves are included for Ba, Cs, Rb, Sr, NaI, and Te systems. Aerosol behavior for accident conditions in reactor containment system is analyzed. 5 references. (D.C.C.)

11209 (DOCKET-1153-5) SAFETY ANALYSIS OF THE HALLAM NUCLEAR POWER FACILITY SITE AND REMAINING STRUCTURES. Final Status Report. (Atomics International, Canoga Park, Calif.). 30 Sep 1969. 229p. (AI-AEC-MEMO-12794(Rev.1)). Dep. CFSTI.

For Consumers Public Power District, Hallam, Nebr.

The retirement isolation structure for the Hallam Power Reactor is detailed; materials removed from the site are described. Radioactivity levels within the isolation structure are tabulated for core and intervals, Area No. 1 reactor vessel and components, and Area No. 2 reactor vessel and components. Straining of the reactor vessel and heat transfer loops is detailed. Sealing and weatherproofing of the isolation structure to prevent water intrusion and personnel entry is discussed. Detailed site data are given for the Hallam plant site. A safety evaluation of the potential loss of integrity of the isolation structure and the associated potential hazards is detailed. Criteria for the retirement program are defined. Radionuclide content in the concretes around Hallam are tabulated for decay periods greater than five years; components stored within the isolation structure are tabulated by location. (M.L.S.)

11210 (NEDO-10029) AN ANALYTICAL STUDY ON BRITTLE FRACTURE OF GE-BWR VESSEL SUBJECT TO THE DESIGN BASIS ACCIDENT. Licensing Topical Report. Hsu, L. C. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Jun 1969. 43p. Dep. CFSTI.

An investigation of General Electric Company Boiling Water Reactor pressure vessels' structural integrity during a design basis accident (DBA) was conducted. It was determined that no failure of the vessel by brittle fracture as a result of a DBA will occur based upon the methods of fracture mechanics. The investigation included (1) a compressive thermal analysis considering the effect of blowdown and the low pressure coolant injection (LPCI)

system reflooding, (2) a stress analysis considering the effects of pressure, temperature, seismic load, jet load, dead weight, and residual stresses, (3) the radiation effect on material toughness (NDTT Shift and Critical Stress Intensity), and (4) methods for calculating crack tip stress intensity associated with a non-uniform stress field following the design basis accident. (auth)

11211 (NEDO-10045) CONSEQUENCES OF A STEAM LINE BREAK IN A GENERAL ELECTRIC BOILING WATER REACTOR. Hench, J. E. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Jul 1969. 58p.

The consequences of a steam line break outside the primary containment on a boiling water reactor system are investigated. The analytical methods used to determine the system response are described and the bases for major assumptions are discussed in detail. Experimental evidence in support of the models is also presented. The results of the analysis show that there is no significant fuel clad temperature rise before isolation value closure. (4 references) (auth)

11212 (ORNL-TM-2412(Pt.3)) DESIGN CONSIDERATIONS OF REACTOR CONTAINMENT SPRAY SYSTEMS. PART III. THE CORROSION OF MATERIALS IN SPRAY SOLUTIONS. Griess, J. C.; Bacarella, A. L. (Oak Ridge National Lab., Tenn.). Dec 1969. Contract W-7405-eng-26. 20p. Dep. CFSTI.

The use of aqueous solutions containing various chemicals for nuclear reactivity control and iodine absorption has been proposed as a safeguard system in water-cooled nuclear reactors. In the event of a design basis accident such solutions would be sprayed into the containment building to reduce the steam pressure and to scavenge I_2 from the atmosphere. For such a system to be practical it must not only accomplish the above two objectives but the corrosive nature of the solution must be such that the containment and emergency equipment must not be jeopardized, thereby propagating the accident. A program was undertaken to determine the corrosion rates of materials normally found in reactors and their containment buildings in spray solutions. Specimens of materials were exposed, both in the spray and totally submerged, over the temperature range of 50 to 140°C. The results of these tests are presented. (auth)

11213 (ORNL-TM-2412(Pt.6)) DESIGN CONSIDERATIONS OF REACTOR CONTAINMENT SPRAY SYSTEMS. PART VI. HEATING OF SPRAY DROPS IN AIR-STEAM ATMOSPHERES. Parsly, L. F. (Oak Ridge National Lab., Tenn.). Jan 1970. Contract W-7405-eng-26. 26p. Dep. CFSTI.

In a loss-of-coolant accident, cold water sprays are frequently used to reduce the containment pressure. It has generally been assumed that the drops would attain thermal equilibrium with the air-steam mixture in the containment atmosphere. A numerical procedure was developed to calculate the time for a cold water drop to approach the temperature of the atmosphere. Calculations were made for typical drop sizes (500, 1000, 1500, 2000, 3000, and 4000 μ diameter) under hypothetical accident conditions. The results of the calculations confirm the assumption that the drops will essentially come to thermal equilibrium with the atmosphere in full-size reactor containment buildings. (auth)

11214 (ORNL-TM-2777) ORNL NUCLEAR SAFETY RESEARCH AND DEVELOPMENT PROGRAM BIMONTHLY REPORT, SEPTEMBER-OCTOBER 1969. Cottrell, Wm. B. (Oak Ridge National Lab., Tenn.). Jan 1970. Contract W-7405-eng-26. 174p. Dep. CFSTI.

The accomplishments during the months of September and October in the research and development program under way at ORNL as part of the U. S. Atomic Energy Commission's Nuclear Safety Program are summarized. Much of this work is in general support of water-cooled power reactor technology, including LOFT and industry programs, and reflects current safety problems, such as measurements of prompt fuel element failure phenomena and the efficacy of containment-spray and pool-suppression systems for fission-product removal. Also included are studies on the release and behavior of accident-released fission products, as well as the removal of these fission products and aerosols from gas streams by filters and adsorbers. Several projects are also conducted in support of the high-temperature gas-cooled reactor (HTGR) and liquid-metal fast breeder reactor (LMFBR) programs. Other major projects include studies of primary piping and steel pressure-vessel technology. Experimental work relative to pressure-vessel technology includes investigations of the attachment of nozzles to shells and the implementation of joint AEC-PVRC programs on heavy-section steel technology and nuclear piping, pumps, and valves. Several of the projects are directly related to the AEC's standards program, which entails development of engineering safeguards and the establishment of codes and standards for government-owned or -sponsored reactor facilities. The recent activities of NSIC and the Nuclear Safety journal in behalf of the nuclear community are also discussed. Of particular interest in both of these activities is the recent emphasis on environmental effects. (auth)

11215 (ORNL-TM-2805) EFFECT OF CONTAINMENT SPRAY SOLUTION ON TRAPPING OF RADIOACTIVE METHYL IODIDE FROM FLOWING STEAM-AIR BY IODIZED CHARCOAL: WESTINGHOUSE TEST SERIES. Ackley, R. D.; Adams, R. E. (Oak Ridge National Lab., Tenn.). Jan 1970. Contract W-7405-eng-26. 27p. Dep. CFSTI.

The effect of applying containment spray solution to iodized charcoal on its capability for decontaminating radioactive methyl iodide ($CH_3{}^{131}I$) transported in flowing steam-air has been investigated in a series of five tests. Approximate conditions for each decontamination test included 130°C (266°F), 55 psia, steam-air face velocity of 40 fpm, 6 mg CH_3I/m^3 injected for 1.5 hr, and a calculated average relative humidity near 100%. All five tests were on one type of iodized charcoal, viz., MSA 85851 (ORNL No. 021369) and all were for the case of downward flow. The aqueous spray solution contained 2000 ppM B, on a weight basis, added as $Na_2B_4O_7$. In two tests, the spray solution was sprayed onto the iodized charcoal to the extent of 20 wt % prior to loading the charcoal into the test section. In two other tests, the spray solution was injected into the flowing steam-air just upstream of the charcoal, with the spray injection period preceding the introduction of methyl iodide; the amounts of spray involved were 20 wt % in one case and 40 wt % in the other. The fifth test was performed somewhat similarly except gross flooding preceded spray injection and the amount of spray employed was 147 wt %. Comparison of these results with previous results indicated that the introduction of spray to the extent of 20 wt % by either manner of application caused relatively unimportant losses in $CH_3{}^{131}I$ decontamination capability, and the indicated loss associated with the test where 40 wt % pertained was moderately larger. In the case where flooding of the charcoal plus 147 wt % spray injection was involved, the overall loss in $CH_3{}^{131}I$ decontamination capability was large, but was not much larger than previously observed when flooding (to a similar degree) alone was induced. (auth)

11216 (SWND-5) RECOMMENDED ALLOWABLE MEMBRANE SHEAR STRESSES FOR RESISTING EARTHQUAKE FORCES IN CONTAINMENT STRUCTURES. (Stone and Webster Engineering Corp., [New York]). Nov 1969. 121p.

The design aspects of plate steel lined, steel rebar reinforced, concrete containment shells for water cooled reactors are examined. In typical containment shells the pressure loading produces principal membrane tensions along meridian lines and parallel circles. Because of these forces and for construction practicalities, it is customary to orient the principal membrane rebar steel along these same directions. Loadings associated with lateral earthquake accelerations and with wind produce principal membrane stresses not so oriented. A series of tests on the ability of reinforced concrete shells to resist such lateral forces are described and recommendations are presented on "lower bound" limits of shear resistance. Also included is a description of specimen data, test variables, and test results on the behavior of 16 large pre-cracked concrete specimens subjected to reversing shearing forces applied along the plane of the crack. (H.D.R.)

11217 (TRG-Report-1949) PROBABILITY APPROACH TO SAFETY ANALYSIS. Pugh, M. C. (United Kingdom Atomic Energy Authority, Risley (England). Reactor Group). 1969. 12p. Dep. CFSTI (U. S. Sales Only). UK 2s. 6d.

A brief description is given of methods employed by the Steam Generating Heavy Water Reactor Design Office in the application of probability theory to achieve a safe and economic design. Although specifically related to the design of SGHWRs, the methods employed are of a general nature and could be equally applied to other reactor systems. 6 references. (auth)

11218 (WAPD-TM-800) FLASH-3: A FORTRAN IV PROGRAM FOR THE SIMULATION OF REACTOR PLANT TRANSIENTS IN SPACE AND TIME. Murphy, J. H.; Redfield, J. A.; Davis, V. C. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Jul 1968. Contract AT(11-1)-Gen-14. 79p. Dep. CFSTI.

The FLASH-3 digital computer program, an improved version of FLASH-2, simulates severe transients in pressurized water reactor plants in which the variation of pressure is significant in both space and time. The program is specifically intended to treat the loss-of-coolant accident with emergency core cooling systems, but also can simulate decompression phenomena in pipes, water hammer effects, check valve slam, and general fluid

network problems. The program is written in FORTRAN IV for the CDC 6600. (auth)

11219 CONTAINMENT SYSTEMS FOR NUCLEAR REACTORS. van der Lugt, G. Electrotechniek, 47: 216-21(May 1, 1969). (In Dutch).

Several methods are described for the containment of the fission products within the plant after a serious reactor accident. 28 references. (auth)

Power Conversion Systems

Refer also to abstract 9568.

Research and Test Reactors

Refer also to abstracts 9451, 9621, 9638, 9679–9683, 9716, 10124, and 11169.

11220 (BNWL-428) FTR CONTROL ROD CALCULATIONS. Harris, R. A.; Maas, L. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Sep 1967. Contract AT(45-1)-1830. 18p. Dep. CFSTI.

The worths of representative in-core and reflector poison rods in an 800 l, zoned, oxide fueled FTR core are shown. The variations of these worths with both rod composition and rod location are described. The accuracy of the values obtained are adequate for preliminary design purposes since the methods employed compare reasonably well with experiments. (auth)

11221 (BNWL-791) SYSTEM EFFECTIVENESS GOALS FOR THE FAST FLUX TEST FACILITY. Harvey, R. A.; Hintze, S. S.; Martin, H. C.; McLaughlin, M. A.; Monteith, O. B. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Nov 1969. Contract AT(45-1)-1830. 34p. Dep. CFSTI.

The Fast Flux Test Facility (FFTF) is an experimental facility intended for use in developing the technology for efficient electric power generation from nuclear energy. An effective design for the FFTF must allow for equipment random malfunctions in order to achieve high system availability for its intended use. System effectiveness goals are presented, and a reliability program aimed at achieving high plant effectiveness is described. The goals are intended for the guidance of subsystem designers. The reliability program indicates the types of analyses and documentation recommended by the authors. (11 references) (auth)

11222 (BNWL-1049) STATE OF TECHNOLOGY STUDY: PUMPS EXPERIENCE WITH HIGH-TEMPERATURE SODIUM PUMPS IN NUCLEAR REACTOR SERVICE AND THEIR APPLICATION TO FFTF. Babcock, W. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Dec 1969. Contract AT(45-1)-1830. 92p. Dep. CFSTI.

A state of technology survey has been made defining design features, development problems, and operating experience for high-temperature Na pumps that have some extrapolation value for the FFTF Reactor Plant. It has been found that Fermi type pumps are best suited to meet FFTF pump requirements, for both main and closed loop systems. The total analysis indicates that FFTF could go "on line" with maximum predictable reliability with the Fermi type of main heat transport and closed loop systems pumps. 20 references. (auth)

11223 (BNWL-1170) CORE RADIAL CONSTRAINT THEORY AND APPLICATIONS TO THE FTR. Jakub, Marlyn T.; Sutherland, W. Howard (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Nov 1969. Contract AT(45-1)-1830. 132p. Dep. CFSTI.

Core restraint work completed for conceptual design of the Fast Test Reactor (FTR) during 1967 is described. The design is based primarily on the dispersed conical core concept but is equally applicable to other core arrangements. The effect of radiation-induced stainless steel swelling was unknown during this period. Only thermal bowing and its effects are considered. 17 references. (auth)

11224 (BNWL-1218) DYNAMIC SIMULATION OF THE FFTF HEATING AND VENTILATION SYSTEM. Madsen, R. N.; Christensen, S. H. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Nov 1969. Contract AT(45-1)-1830. 123p. Dep. CFSTI.

A mathematical simulation for digital computer analysis of the dynamic temperature behavior of selected portions of the Heating and Ventilation System of an FFTF conceptual design is described in detail. This simulation is used to investigate the temperature responses for various levels of system operation following a loss of normal electrical power to the facility. Typical results for various modes of operation are presented. The results indicate that temperature increases of less than 10°F can be obtained with about one-third to one-fourth the normal system cooling capacity, considering the reduced requirements then in effect. 13 references. (auth)

11225 (BNWL-1236) SUGGESTED INTERIM STRUCTURAL DESIGN CRITERIA FOR THE FTR PRIMARY PIPING SYSTEM. Jakub, Marlyn T.; (and others) (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Dec 1969. Contract AT(45-1)-1830. 50p. Dep. CFSTI.

A set of structural design criteria for the primary system piping of the Fast Test Reactor is presented. This piping is to provide a 20-year-life, thin-walled, type 304H SS conduit for 1200°F liquid sodium at pressures of ~300 psi. The presentation comprises the official minutes of the meeting of AEC and industry experts who formulated the criteria and also records the background discussion and reasoning. Future development needs for design with materials at creep temperatures are outlined. (auth)

11226 (BNWL-1258) REFLECTOR SAVINGS FOR URANYL NITRATE OF LOW ENRICHMENT. Rogers, C. A.; Lloyd, R. C.; Bierman, S. R.; Clayton, E. D. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Nov 1969. Contract AT(45-1)-1830. 31p. Dep. CFSTI.

Reflector savings for 2.14 and 3.04 wt % ^{235}U enriched $UO_2(NO_3)_2$ reflecting a cuboidal core of PuO_2-polystyrene were experimentally determined and compared with calculations using the HFN and DTF codes. HFN-computed reflector savings curves for less than 5.0 wt % ^{235}U enriched $UO_2(NO_3)_2$ reflecting a spherical, water-moderated, U rod lattice are presented with a discussion of the principal parameters which influence reflector savings. 9 references. (auth)

11227 (BNWL-SA-2616) REPAIR OF CASTING FLAWS IN AN EIGHT INCH STAINLESS STEEL CHECK VALVE AT THE PLUTONIUM RECYCLE TEST REACTOR. Purcell, R. H. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). 5 Sep 1969. Contract AT(45-1)-1830. 10p. Dep. CFSTI.

11228 (CEA-CONF-1461) IRRADIATIONS IN THE REACTOR PEGASE. Deville, Andre (Commissariat a l'Energie Atomique, Cadarache (France). Centre d'Etudes Nucleaires). [1968]. 3p. (CONF-691102-12). Dep. CFSTI (U. S. Sales Only).

From 17th Conference on Remote Systems Technology, San Francisco, Calif.

The main characteristics of the PEGASE CO_2-cooled irradiation loops are tabulated. The performance of these loops in past irradiation tests is discussed. (H.D.R.)

11229 (CEA-CONF-1462) OSIRIS: OPERATION AND UTILIZATION STATUS. Bernot, Jacques; Lerouge, Bernard (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). [nd.] 3p. (CONF-691102-11). Dep. CFSTI (U. S. Sales Only).

From 17th Conference on Remote Systems Technology, San Francisco, Calif.

11230 (CONF-690102) FAST BURST REACTORS. Proceedings of the National Topical Meeting held at Albuquerque, New Mexico, January 28–30, 1969. AEC Symposium Series 15. (American Nuclear Society, Hinsdale, Ill.). Dec 1969. 646p. Dep. CFSTI.

Included are 37 papers on the design, analysis, and operation of fast burst and repetitively pulsed reactors. Five papers were previously abstracted for NSA and may be located under CONF-690102 in the Report Number Index. A separate abstract was prepared for each of the remaining 32 papers. (H.D.R.)

For abstracts of individual papers see: 11231–11262.

11231 (CONF-690102-, pp 9-29) COMPARISON OF FAST PULSED REACTOR CALCULATIONS WITH EXPERIMENT. Mihalczo, J. T. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant).

Various methods of solution of the Boltzmann transport equation have been used to predict the properties of fast burst reactors. These methods and their application to the calculation of some properties of some fast burst reactors and associated critical experiments are reviewed. The calculations of criticality, prompt-neutron decay constant, neutron lifetime, fission-density distribution, and reactivity effects are compared with experiment. 29 references. (auth)

11232 (CONF-690102–, pp 31-50) FAST BURST REACTOR KINETICS. McTaggart, M. H. (Atomic Weapons Research Establishment, Aldermaston (England)).

The simple transient response equation of reactor kinetics is the basis of more-sophisticated methods of calculating the behavior of fast burst reactors. The need to stretch burst reactor designs to their ultimate capability, however, has forced designers to extend the simple model. These extensions and their range of validity are examined. Many reactivity-feedback coefficients are nonlinear, e.g., the Doppler effect used in VIPER. In systems with short prompt-neutron lifetimes, such as Godiva and Super KUKLA, inertia effects become important, and the kinetics problem consists in solving coupled kinetics equations that take account of the elastic waves set up in the fuel by the rapid heating. The delayed-neutron fraction and prompt lifetime, which govern the prompt kinetics in many systems, are not well determined at present. Ways of adjusting delayed-neutron parameters to fit the observed reactor behavior are outlined, and experiments suggesting that certain delayed fractions may be in error are discussed. 23 references. (auth)

11233 (CONF-690102–, pp 81-93) HISTORY AND DEVELOPMENT OF FAST BURST REACTORS, 1944–1965. Wood, David P. (Albuquerque Operations Office (AEC), N. Mex.); O'Brien, Paul D. (Sandia Corp., Albuquerque, N. Mex.); Wimett, Thomas F. (Los Alamos Scientific Lab., N. Mex.).

A brief history of the development of fast burst reactors during the period 1944–1964 is given, including comments on a reactor built in the Soviet Union and the eight fast burst reactors built and operated in the United States. Practical applications of fast burst reactors, their origin, physical characteristics, modes of operation, and limitations are discussed. 14 references. (auth)

11234 (CONF-690102–, pp 95-104) GODIVA IV. Wimett, Thomas F.; White, Roger H.; Wagner, Robert G. (Los Alamos Scientific Lab., N. Mex.).

Preliminary results obtained with a new fast burst assembly are presented. The fuel is U–1.5 wt. % Mo alloy. Assembly features include a new scheme for securing fuel components in the core. 13 references. (auth)

11235 (CONF-690102–, pp 105-23) SANDIA PULSED REACTOR II. Jefferson, R. M. (Sandia Labs., Albuquerque, N. Mex.).

On the basis of experience gained from the operation and evaluation of other fast burst reactors, the SPR II was designed to be capable of producing a fast-neutron fluence of 10^{15} in a 35-μsec pulse inside a 1.5-in.-diameter glory hole. This second-generation fast burst reactor uses 105 kg of 93% enriched uranium alloyed with 10 wt. % molybdenum as fuel, which, when fully assembled, forms a right-circular cylinder 810 in. in diameter by 8.2 in. in height. During the extensive operating history of this reactor, a number of design innovations and operational techniques have been developed to allow higher levels of operation, increased reliability, and improved safety. These developments and operational experiences involving fuel failures are detailed. 11 references. (auth)

11236 (CONF-690102–, pp 125-37) THE VIPER CORE. McEnhill, J. J. (Atomic Weapons Research Establishment, Aldermaston (England)).

The VIPER reactor was first pulsed supercritical in August 1967. Since then, 150 bursts have been produced. The pulse width is 400 μsec, and the peak yield is 3.5×10^{17} fissions. In principle the reactor is similar to Godiva, but it has certain different features. The core consists of fuel rods of partly enriched uranium embedded in a matrix of copper and epoxy resin. The prompt negative coefficient of reactivity is largely due to the Doppler effect in ^{238}U, an effect which is enhanced by the moderating properties of the epoxy resin. 2 references. (auth)

11237 (CONF-690102–, pp 139-59) DESIGN OF THE ARMY PULSE RADIATION FACILITY REACTOR. Yockey, H. P. (Ballistics Research Labs., Aberdeen Proving Ground, Md.); Lundin, M. I. (Oak Ridge National Lab., Tenn.); Stathoplos, A. (Nuclear Technology Corp., White Plains, N. Y.).

The design objectives established for the Army Pulse Radiation Facility Reactor require a surface fluence of 1 to 3×10^{14} neutrons cm^2 per burst, a burst width of 40 $\pm$ 5 μsec, a peak flux at the core surface of 2 to 3×10^{18} neutrons/cm^2/sec, a total fission yield of 1 to 3×10^{17}, steady-state operation at 10 kW, and burst repetition in 2 hr. A parametric study of the Health Physics Research Reactor led to a core of large diameter and smaller height-to-diameter ratio, making possible the inclusion of a glory hole 1.5 in. in diameter. Each core part is aluminum-ion plated to control corrosion. The core is kept in an atmosphere of dry nitrogen to control stress-corrosion cracking. All design specifications were met or exceeded. 11 references. (auth)

11238 (CONF-690102–, pp 161-70) EXPERIENCE WITH FAST BURST REACTOR MATERIALS. Farkas, M. S. (Battelle Memorial Inst., Columbus, Ohio).

The properties of α-phase and γ-phase U alloys are compared with respect to fast burst reactor design and operation. Particular emphasis is given to problems associated with the use of the U–10 wt. % Mo fuel. Possible future directions in alloy development are examined. 5 references. (auth)

11239 (CONF-690102–, pp 173-95) OPERATIONAL EXPERIENCE AND DEVELOPMENT OF PERIODICALLY PULSED REACTORS AT DUBNA. Anan'ev, V. D.; Blokhintsev, D. I.; Bunin, B. N.; (and others) (Joint Inst. for Nuclear Research, Dubna (USSR)).

A number of design improvements made on the IBR on the basis of operational experience are described. Some peculiarities of the reactor under operating conditions of infrequent pulses are given along with a short description and the main parameters of the high-power periodically pulsed reactor IBR-2 with an LIU-30 as an injector. Some major experimental works on nuclear physics and solid-state physics performed using the IBR are discussed. 34 references. (auth)

11240 (CONF-690102–, pp 237-61) SHORT MODERATOR PULSES AND BOOSTER SYSTEMS. Fluharty, R. G. (Los Alamos Scientific Lab., N. Mex.).

A simple description of booster and accelerator-pulsed reactor properties is given in terms of point reactor kinetics. A concept of an accelerator pulsed reactor of ~3 MW average power and 5-μsec pulse widths at pulse rates up to 200 pulses/sec is presented. The major features are ^{239}Pu fuel and a partially voided core concept which yields shorter neutron lifetimes and flexible moderator and flight-path configurations by eliminating beam tubes. Methods for obtaining short moderator pulses are illustrated with methods for estimating beam intensities. 11 references. (auth)

11241 (CONF-690102–, pp 265-85) SORA. Larrimore, J. A.; Haas, R.; Giegerich, K.; Raievski, V.; Kley, W. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center).

The pulsed reactor SORA, designed at the Common Research Center of EURATOM at Ispra as a source for neutron-physics experiments, is described. The design of the reactor facility and its operational characteristics are reviewed, and operational control and safety and reactor safeguard considerations are discussed. 24 references. (auth)

11242 (CONF-690102–, pp 289-301) SURVEY OF FAST BURST REACTOR OPERATING PROCEDURES. Long, Robert L. (New Mexico Univ., Albuquerque).

The operating procedures of six of the eight operating fast burst reactor facilities are reviewed. Significant variations both in philosophy and in details of operation are discussed. Some recommendations are made for standardization of operations requirements. (auth)

11243 (CONF-690102–, pp 303-12) OPERATIONAL EXPERIENCES WITH FAST BURST REACTORS. Holland, L. B. (Oak Ridge National Lab., Tenn.).

Operational experience with the few fast burst reactors that are utilized as sources of radiation for experimental purposes as opposed to those that are used to study the kinetics of the reactor itself is presented. The reactors discussed include the HPRR, the SPR II, Super KUKLA, VIPER, and the WSMR reactor. In addition to some statistics on the performance of the reactors, the integrity of the fuel elements, the mechanical support structure, the reactor instrumentation, and problems encountered with experiments, maintenance, and operation are examined. 2 references. (auth)

11244 (CONF-690102–, pp 313-22) FAST BURST REACTOR EXPERIMENT IRRADIATION EXPERIENCE. De La Paz, A. (White Sands Missile Range, N. Mex.).

Extensive experience accumulated during irradiation of experiments in fast burst reactor facilities has demonstrated that the effect of the experiment being irradiated on the reactor characteristics is the primary operational safety consideration. The general nature of these effects and the associated procedures to be applied are presented for various categories of fast burst reactor experiments. 16 references. (auth)

11245 (CONF-690102–, pp 323-51) REFLECTOR AND DECOUPLING EXPERIMENTS WITH FAST BURST REACTORS. Coats, Richard L. (Sandia Labs., Albuquerque, N. Mex.); Long, Robert L. (New Mexico Univ., Albuquerque).

Results are reported of systematic studies of various reflector effects on burst characteristics conducted at the White Sands Missile Range Fast Burst Reactor Facility and at the Sandia Pulsed Reactor Facility. A calculation model is described, and the calculated results are compared with experimental findings. 10 references. (auth)

11246 (CONF-690102–, pp 353-71) PREOPERATIONAL TEST EXPERIENCE WITH THE ARMY PULSE RADIATION FACILITY REACTOR. Kazi, A. H.; Dubyoski, H. G.; Dickinson, R. W. (Ballistic Research Labs., Aberdeen Proving Ground, Md.).

Data obtained in preoperational tests of the Army Pulse Radiation Facility Reactor are summarized. During these tests a pulse with a yield of 6.09×10^{17} fissions was obtained, which is three times larger than the anticipated maximum operational yield. The center third of the safety block was melted. The centrally located fuel rings were distorted, and cracks have appeared between the holes and the inner diameter. The bolts were stretched and slightly bent but not broken. The pulse rod, regulating rod, and mass adjustment rod were slightly bent. Most of the U–10 wt. % Mo fuel parts no longer meet the original specifications and must be replaced for pulse operation. There was little or no damage to rod drive, supports, etc, no overexposure to radiation of the operations personnel, and no detectable external or airborne radioactive hazards. A number of changes in design, instrumentation, and procedure are being made to place the reactor into full operation at levels of approximately 2×10^7 fissions/pulse and 10 kW steady state. 7 references. (auth)

11247 (CONF-690102–, pp 373-84) FAST BURST REACTOR OPERATIONAL INCIDENTS. O'Brien, Paul D. (Sandia Labs., Albuquerque, N. Mex.).

The causes of 10 typical fast burst reactor incidents, the consequences of the incidents, and the actions taken to prevent recurrences are discussed. These 10 incidents by no means cover the spectrum of possible accident mechanisms; however, they do illustrate the overriding importance of administrative control in providing for safe operation under the almost unbelievably wide range of experimental conditions to which fast burst reactors are adaptable. 6 references. (auth)

11248 (CONF-690102–, pp 387-402) HIGH-YIELD MOLTEN-SALT BURST REACTOR. Perry, A. M. (Oak Ridge National Lab., Tenn.).

A pulsed molten-salt reactor appears capable of producing neutron fluences of 10^{16} neutrons/cm^2 in neutron-irradiation specimens in single bursts with widths of less than 1 msec. A reactor design is presented which achieves these goals, using as fuel the eutectic salt LiF–UF_4 (73–27 mole %). Neutronic, mechanical, and hydraulic analyses of the reactor are discussed. 3 references. (auth)

11249 (CONF-690102–, pp 403-26) SANDIA BOOSTER ASSEMBLY (EDNA PROGRAM). Coats, R. L. (Sandia Labs., Albuquerque, N. Mex.).

A description is given of the Electron Driven Nuclear Assembly (EDNA) concept being studied at Sandia Laboratory. The EDNA concept employs a 25-MeV 200,000-amp electron generator and a compact multiplying assembly. The design objective of the program is to provide a neutron fluence of approximately 1×10^{15} neutrons/cm^2 per pulse. The pulse width at half-maximum intensity is restricted to 1 μsec. 10 references. (auth)

11250 (CONF-690102–, pp 443-51) MAXIMUM BURST YIELDS FROM COATED-PARTICLE REACTORS. Adler, F. T. (Illinois Univ., Urbana. Dept. of Physics).

In view of the performance of coated-particle fuels (uranium carbide coated by pyrocarbon and imbedded in a graphite matrix) in various reactor systems, the ultimate potential of such fuels in terms of attainable burst widths and maximum energy depositions is considered. Limitations inherent in the characteristics of the pyrocarbon shell are discussed. 3 references. (auth)

11251 (CONF-690102–, pp 455-68) SURVEY OF SAFETY INSTRUMENTATION AND INTERLOCK REQUIREMENTS. Shon, Frederick J. (Atomic Energy Commission, Washington, D. C.).

Criteria for burst-reactor safety systems are examined critically. Systems usually called "safety" systems are found to have only a small influence on safe operation of burst reactors. Devices that reduce the change of an oversized burst, more properly considered safety systems, are reviewed, and the coincidence and redundancy requirements for all systems are noted. It is concluded that the prime safety factors in the operation of a fast burst reactor are care and intelligence on the part of the operators, that these factors can be aided by properly designed safety systems, and that the need for redundancy and coincidence logic in these systems is inextricably bound up with the operating procedures in use. 10 references. (auth)

11252 (CONF-690102–, pp 469-77) TIME-DEPENDENT DOSIMETRY AND SPECTROSCOPY. Kronenberg, S.; Lux, R. A. (Army Electronics Command, Fort Monmouth, N. J. Inst. for Exploratory Research).

Requirements for instrumentation to measure dose rate and time-dependent neutron and γ-ray spectra from fast burst reactors are discussed. Specific dose-rate measuring systems are compared. Techniques for obtaining time-dependent spectra are discussed. 12 references. (auth)

11253 (CONF-690102–, pp 479-96) DIGITAL REACTOR PERIOD COMPUTATIONS. Kenney, E. S.; Schultz, M. A. (Pennsylvania State Univ., University Park. Dept. of Nuclear Engineering).

Three methods of digitally extracting reactor period are discussed for pulse-detector inputs. One of the methods discussed is explored in detail to investigate the limits of accuracy for pulse-detector input systems. Also, a simulation of the device proposed has been set up on a large digital computer to optimize the selectable parameters. Hybrid period systems for pulsing reactors are introduced with a limited treatment of their function. 6 references. (auth)

11254 (CONF-690102–, pp 519-30) DEVELOPMENT AND APPLICATION OF FISSION-COUPLES. Morrison, R. G. (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.).

During the past several years a form of intrinsic thermocouple, called a fission-couple, has been used by a number of experimenters to monitor fast temperature transients on reactor fuels. In this application a small piece of fuel is used as the sensing device. The temperature of the sensor is monitored by attaching very fine thermocouple wires to the fuel. This technique has demonstrated that actual reactor periods as short as 10 μsec can be measured accurately. The device is being adapted to neutron-flux measurement problems by normalizing the observed temperature rise to known neutron fluxes. The normalization is dependent on the validity of standard flux measurements determined by activation or radiochemical analysis. The enthalpy of the fissile element in the sensing part of the detector and a mathematical model for determining heat losses due to the various mechanisms present in the particular geometric application are discussed. Several specific applications now being used and available data from these experiments are described. 11 references. (auth)

11255 (CONF-690102–, pp 533-41) ESSENTIALS OF FAST BURST REACTORS SAFEGUARDS ANALYSIS. Seale, Robert L. (Arizona Univ., Tucson).

A review of the reactor safeguards analysis methods for fast burst reactors emphasizes the essential difference between fast burst reactors and the power reactors that have a dominant influence in the safeguards analysis literature. This difference is the much smaller fission-product inventory present in the fast burst reactor. The objective of safeguards analysis is usually stated as verifying the protection of the public from any exposure to radiation produced by the reactor. Present criteria established for operating facilities meet this objective. Considering a more restrictive requirement, mainly the protection of personnel at the facility, the record of recent years shows that the concept of remote operation has provided the means of meeting this objective. Finally, there is hope that the establishment of an appropriate set of operating limits can provide the vehicle by which protection of the reactor itself may be attained. Whether or not this hope is fulfilled depends very strongly on the definition of a realistic set of operating limits and on the measures taken when operating limits are violated. Operating limits should be defined such that a violation is a clear indication of unsatisfactory performance. Under these circumstances the management of the facility could then take action to analyze the cause of exceeding the operating limits and to assure the future observance of operating limits, greatly reducing the chances of an incident that could damage the reactor. In effect, it is suggested that a violation of the operating limits be treated as an administrative incident of relatively serious proportions. It is important that the spirit of the operating limit not be diluted by the inclusion of trivial restrictions that do not bear on the safety of reactor operation. The operating limits should be clearly and unambiguously stated, and their enforcement should be a prime responsibility of the facility management. 12 references. (auth)

11256 (CONF-690102–, pp 543-7) SOME ASPECTS OF RISK ASSESSMENT IN RELATION TO A BURST REACTOR. Farmer, F. R. (United Kingdom Atomic Energy Authority, Risley (England). Authority Health and Safety Branch).

A quantitative technique previously proposed is used selectively to discuss some aspects of burst reactor safety. It is concluded that, subject to certain provisos, a fast burst reactor can, in principle, be designed and operated within the safety targets proposed. In addition, apart from safety considerations, the need to "protect investment" leads to criteria of the same order as those derived from safety requirements. (auth)

11257 (CONF-690102–, pp 549-59) STANDARD FOR FAST BURST REACTORS. De La Paz, A. (White Sands Missile Range, N. Mex.).

The accumulated experience and continued development and use of fast burst reactors make it essential that a standard be developed for the operation of these reactors. The efforts of American Nuclear Society subcommittee N14 have led to the development of a standard based on the full use of the experience gained to date. This standard, when formalized and issued, should be of considerable use to personnel involved in the design, operation, and regulatory review of fast burst reactors. (auth)

11258 (CONF-690102–, pp 563-77) NEUTRON DIFFRACTION USING REPETITIVELY PULSED SOURCES. Brugger, R. M. (Idaho Nuclear Corp., Idaho Falls); Beckurts, K. H. (Brookhaven National Lab., Upton, N. Y.).

The methods of neutron diffraction and possible experiments are outlined. The advantages of such methods are established, and the ability to increase the effective experimental capabilities is demonstrated. The mentioned experiments demonstrate the need for a continued effort to increase the effectiveness of slow-neutron-scattering experiments. 4 references. (auth)

11259 (CONF-690102–, pp 595-605) FISSION-NEUTRON PULSE RADIOLYSIS. Theard, L. M.; Russell, J. L. Jr. (Gulf General Atomic, Inc., San Diego, Calif.).

In the past only pulsed electrons and x rays have been used in pulse radiolysis. However, certain fast burst reactors generate neutron pulses that are usable for pulse radiolysis studies. The data that might be obtained from such studies on biochemical systems have an important relevance to radiobiology and radiation therapy. The proposed use of the Accelerator-Pulsed Fast Critical Assembly (APFA-III) for fission-neutron pulse radiolysis studies is discussed. 6 references. (auth)

11260 (CONF-690102–, pp 609-12) TEACHING APPLICATION OF FAST BURST REACTORS IN UNIVERSITY PROGRAMS. Whan, Glenn A. (New Mexico Univ., Albuquerque).

Some of the ways in which small bare fast systems can be incorporated into both classroom calculations and laboratory demonstrations are discussed. The ways in which these reactors have been incorporated into the University of New Mexico teaching program are described. (H.D.R.)

11261 (CONF-690102–, pp 613-23) UNIVERSITY RESEARCH USING FAST BURST REACTORS. Miley, George H. (Illinois Univ., Urbana); Kurstedt, Harold A. (Ohio State Univ., Columbus).

Past university research involving fast burst reactors is reviewed. Several studies related to reactor kinetics and reactor development are discussed. Use of the reactor as a pulsed source to study neutron pulse propagation and radiobiological studies requiring both a pulsed and a steady-state fast-neutron source are also reviewed. A surprising lack of university involvement in studies of radiation effects on materials and electronics is discussed. On the basis of this review, as well as research reported by nonuniversity investigators, some promising future research areas are suggested along with a discussion of possible means of carrying out off-campus research of this type. 34 references. (auth)

11262 (CONF-690102–, pp 625-8) DESIGN PROBLEMS. O'Brien, Paul D. (Sandia Labs., Albuquerque, N. Mex.).

Problems in the design, analysis, and operation of fast burst reactors that are amenable to solution through the efforts of university students and faculty are discussed. (H.D.R.)

11263 (EURFNR–709) THE P.E.C. REACTOR (A FUEL TEST FAST REACTOR). Pierantoni, F.; Fogagnolo, G.; Zona, R.; (and others) (Comitato Nazionale per l'Energia Nucleare, Bologna (Italy)). [1967]. 67p. (PRV–(67)13; CONF-670413–3). Dep. CFSTI (U. S. Sales Only).

From National Topical Meeting on Fast Reactors, San Francisco, Calif.

The PEC fast reactor was designed to carry out in-pile tests on prototype fuel subassemblies for large sodium-cooled power reactors. The planned experimental programs are concerned mainly with closed-loop testing of prototype assemblies under abnormal operating conditions. Experimental facilities of the reactor are described, and general features of the reactor are discussed. Design and performance data on the core and fuel assemblies are tabulated. (H.D.R.)

11264 (FMRB–26/69) MEASUREMENT OF THE SPECTRAL DISTRIBUTION OF NEUTRON FLUX IN THE ENERGY RANGE FROM 1.5 TO 8.0 MeV IN THE TANGENTIAL BEAM TUBE S 2 OF THE BRAUNSCHWEIG RESEARCH AND TESTING REACTOR (FMRB). Kluge, H. (Physikalisch-Technische Bundesanstalt, Brunswick (West Germany)). Jun 1969. 22p. (In German). Dep. CFSTI (U. S. Sales Only).

The neutron spectrum in the energy range from 1.5 to 8.0 MeV was measured by means of a proton recoil telescope in the tangential beam tube S2 of the FMRB. The current density of the thermal neutrons was determined. These data were used for the calculation of $\alpha(E) = B_E^S / B_E^{Sp}$. B_E^S is the differential source strength of the reactor neutrons scattered elastically or inelastically by a converter foil of enriched ^{235}U, and B_E^{Sp} is the differential source strength of the fission neutrons. 11 references. (auth)

11265 (GEAP–10059) AN ANALYTICAL EVALUATION OF THE CONSEQUENCES OF A HYPOTHETICAL INSTANTANEOUS LOSS OF COOLANT FLOW TO A FAST FLUX TEST FACILITY DRIVER FUEL ASSEMBLY. McWethy, L. M. (comp.) (General Electric Co., Sunnyvale, Calif. Breeder Reactor Development Operation). Jul 1969. 203p. Dep. CFSTI.

An evaluation is presented of the consequences of a hypothetical, instantaneous loss-of-flow accident to the Fast Flux Test Facility driver fuel assembly. The circumstances are analyzed under which the accident could propagate to adjacent fuel assemblies. Estimations are presented of the earliest times at which propagation mechanisms could become credible and relate to instrumentation response requirements. The influence of design parameters on the probability of propagation is described. Topics discussed include: fuel failure effects; coolant thermal-hydraulics; molten fuel and Na interaction; duct response; failure propagation; and design and development recommendations. (D.C.C.)

11266 (IFA-FR-78) CORRELATION OF THE ACTIVITY OF THE REACTOR COOLANT WITH APPARENT ABSENCE OF A FUEL ELEMENT CAN BY THE USE OF GAMMA SPECTROSCOPY. Ionescu, Ecaterina (Academia R. S. R., Bucharest. Institutul de Fizica Atomica). 1969. 10p. (In French). Dep. CFSTI (U. S. Sales Only).

11267 (INR-P–1124) CALCULATIONAL METHODS FOR THE DETERMINATION OF THE UNIVERSITY REACTOR UR-100 PARAMETERS. Dabrowski, Cyryl; Malewski, Stefan (Institute of Nuclear Research, Warsaw (Poland)). 1969. 27p. (CONF-691025–1). Dep. CFSTI (U. S. Sales Only).

From Seminar on Reactor Physics Calculations, Budapest, Hungary.

A series of calculations was performed to determine the physical parameters of the UR-100 reactor. In the thermal neutron range the programme THERMOS was used to obtain the lattice parameters. The epithermal and fast neutron data were calculated by means of the program PARAV and alternatively by the 26-group program MIXER. The criticality calculations were done analytically by the CRUX 2G2Z RECT and CYL programs, and numerically by the one-dimensional multigroup diffusion EWA-1 program. The program BLACKROD was developed and used in calculation of control rod reactivity worth. (auth)

11268 (N–69-39186) ANALYSIS AND EXPERIMENTS WITH A PULSED NEUTRON SOURCE FOR AN UNREFLECTED SOLUTION REACTOR UP TO 50 DOLLARS SHUTDOWN. Fieno, Daniel; Fox, Thomas A.; Mueller, Robert A.; Ford, C. Hubbard (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Oct 1969. 59p. (NASA-TN-D–5487). CFSTI.

Pulsed-source experiments have been performed for an unreflected, cylindrical solution reactor for heights varying from delayed critical to highly subcritical systems. The fuel solution consists of enriched (93.2% ^{235}U) as UO_2F_2 dissolved in water. For these experiments a H to ^{235}U atom ratio of 975 is used, thus giving highly thermal reactor spectra. Multigroup-transport-theory-calculated values of the fundamental prompt-mode decay constant are compared with experimental values. Also, calculated

values for the subcritical reactivity are compared with values obtained from the experiments by using the inhour method, the method of Simmons and King, and the three well-known "area-ratio" methods—those of Garelis and Russell, Sjöstrand, and Gozani. (auth) (STAR)

11269 (ORNL-TM-2759) CONCEPTUAL STUDY OF DISASSEMBLY-REASSEMBLY EQUIPMENT FOR EXAMINATION OF FFTF CORE COMPONENTS AND TEST ASSEMBLIES. Baird, J. N.; Beckers, R. M.; Davis, F. C.; Duggan, H. G., Hill, R. M. (Oak Ridge National Lab., Tenn.). Jan 1970. Contract W-7405-eng-26. 181p. Dep. CFSTI.

For Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.

A concept of the disassembly-reassembly equipment to be located in the Interim Examination and Disassembly Cell at the proposed Fast Flux Test Facility in Richland, Washington, is described. This equipment is comprised of two positioning machines, two sets of accessory tooling, and the necessary controls. Each machine is a 58.5-ft-tall in-cell device that is remotely operable, semiautomatic, and manipulator assisted. As conceived, each machine will accept a vertically oriented irradiated core component or test assembly up to about 43 ft long and position it for disassembly and examination operations. Test assembly may also be reassembled. The baseline information from which the concept was developed is discussed; a physical description of the machine and some of the tooling is given; and proposed principles of operation and maintenance, safety considerations, development programs, quality assurance measures, and the time-cost schedule for design, fabrication, and testing are covered. The first machine with its tooling and controls is scheduled for delivery to Richland 46 months after the project start date, and the second machine with its tooling and controls is scheduled for delivery 65 months after the start date. As proposed, the total cost for the design, development, and testing of the disassembly-reassembly equipment is estimated to be $1,632,000. 11 references. (auth)

11270 (RT/ING-(69)5) DYNAMIC TESTS ON MODELS OF PEC NUCLEAR REACTOR CONTAINMENT BUILDING. Lauletta, E.; Castoldi, A. (Comitato Nazionale per l'Energia Nucleare, [Rome] (Italy)). 3 Mar 1969. 38p. (CONF-681224-1). Dep. CFSTI (U. S. Sales Only).

From Conference on Defining the Criteria for Earthquake Protection for a Nuclear Reactor, Bologna, Italy.

A series of tests was carried out on models of the PEC reactor containment building. The response of the structure to seismic soil movement was investigated with the determination of the natural frequencies and shape of the modes and with the application of random vibrations. (auth)

11271 (WARD-3762-5) EXTRAPOLATION OF HALLAM AND FERMI SODIUM PUMPS TO THE FFTF PRIMARY PUMP REFERENCE DESIGN REQUIREMENTS. Bruhl, J. R.; Lamers, R. P.; Nixon, D. R. (Westinghouse Electric Corp., Madison, Pa. Advanced Reactors Div.). Dec 1968. Contract AT(30-1)-3762. 42p. Dep. CFSTI.

The requirements of the sodium pumps for the primary system of the Fast Flux Test Facility (FFTF) are compared with the state of the art as represented by the Enrico Fermi Atomic Power Plant and the Hallam Nuclear Power Facility. A Fermi-type pump is recommended for the FFTF application. (auth)

11272 (WARD-3762-8) RADIATION ANALYSIS AND SHIELDING REQUIREMENTS. Low-Capacity Pump System Side Study. Bland, P. S.; Burch, R. D.; Martin, J. K. (Westinghouse Electric Corp., Madison, Pa. Advanced Reactors Div.). 31 Dec 1968. Contract AT(30-1)-3762. 15p. Dep. CFSTI.

Concrete and stainless steel are selected as the shielding materials for the shield plug of the FFTF primary Na pump. The surface of the radioactive sodium in the pump vessel is ten feet below floor level. Activation γ from ^{24}Na (85 mC/$_g$cm^3) induces nuclear heating in the pump shield plug at a rate of 1.6×10^3 Btu/hr, and over 90% of the heating occurs in the bottom two plates of the plug. A shielding analysis for the pump handling cask and associated floor valves is described. The shielding requirement for the walls of the handling cask range from three- to one-in. thickness of Pb (from the bottom to the top of the cask respectively), to meet the design requirements of 100 mR/hr at the surface of the cask. Structural as well as shielding requirements, resulted in 1.5- and 7.5-in. thick steel being recommended for the upper and lower floor valves, respectively, based on the ^{22}Na activity after 6 days shutdown. 6 references. (auth)

11273 (WARD-3762-10) ON-SITE HANDLING STUDY FOR THE LOW CAPACITY SODIUM PUMP. Wasko, John (Westinghouse Electric Corp., Madison, Pa. Advanced Reactors Div.). 25 Apr 1969. Contract AT(30-1)-3762. 44p. Dep. CFSTI.

A discussion of the on-site handling requirements for a liquid-sodium coolant-system pump is presented. It is intended to serve as a reference manual and aid in designing both the FFTF pump and the physical plant and plant facilities in which the pump would be operated. A method, with associated equipment definitions, for performing major maintenance on the removable pump internals is described. 6 references. (auth)

11274 REACTORS AS NEUTRON SOURCES. Guinn, V. P. (Gulf General Atomic Inc., San Diego, Calif.). Advan. Activ. Anal.; 1: 37-80(1969).

The main features of research-type nuclear reactors are discussed from the standpoint of the activation analysis under the following headings: the thermal neutron ^{235}U fission reaction; the fission spectrum of neutron energies; moderators, reflectors and coolants; critical mass, reactor control and fuel elements; reactor neutron fluxes and flux-monitoring techniques; irradiation of samples in research reactors in neutron activation analysis studied (thermal neutron activations; fast neutron activations; provisions for irradiation of samples; use of recoil protons; use of delayed neutrons; analysis via prompt γ-rays); use of high intensity reactor pulses; and new techniques and new areas of application. Tables include: limits of detection for 71 elements in a thermal neutron flux of 10^{13} n/cm^2/sec (1 hr irradiation); and limits of detection for 73 elements in a fission spectrum neutron flux of 10^{13} n/cm^2/sec (1 hr irradiation). 49 references. (UK)

11275 EXPERIMENTAL COMPUTER-CONTROLLED INSTRUMENTATION SYSTEM FOR THE RESEARCH REACTOR DR2. Goodstein, L. P. (Danish Atomic Energy Commission Research Establishment, Risoe). J. Brit. Nucl. Energy Soc.; 8: 309-19(Oct 1969).

An instrumentation system was developed for one of the Danish Atomic Energy Commission's research reactors as part of an experiment on the advantages to be gained by the use of digital computers in a process plant application. Problem areas to be investigated include (a) reliability and safety, (b) process monitoring and control and (c) man-machine communications. The experimental system configuration is described and relevant hardware and software matters discussed in some detail. (auth) (UK)

11276 DETECTION AND MEASUREMENT OF RADIONUCLIDES IN THE COOLING SYSTEM OF THE PAKISTAN RESEARCH REACTOR. Aziz, Abdul; Ali, Anwar; Mubarak, M. A. (Pakistan Inst. of Nuclear Science and Tech., Islamabad). Nucleus (Lahore); 6: 99-103(Apr-Jun 1969).

The presence of ^{24}Na in the primary cooling system of the Pakistan Research Reactor was detected immediately after the operation of the reactor at full power about the middle of 1966. Recently routine analysis showed the presence of long-lived radioactivity in the reactor cooling system. This was identified as ^{110m}Ag. Experimental determination of the concentration of ^{110m}Ag in the reactor pool and the waste effluent is described. 5 references. (auth)

11277 INFLUENCE OF A REENTRANT HOLE ON MEASUREMENTS OF FAST AND THERMAL NEUTRON SPECTRA. McGirt, Frank; Becker, Martin (Rensselaer Polytechnic Inst., Troy, N. Y.). Nucl. Sci. Eng.; 39: 56-66(Jan 1970).

Qualitative and quantitative understanding of reentrant hole (or extraction channel) effects in pulsed thermal- and fast-neutron experimental assemblies is analyzed. The calculational model used assumes slab geometry for the unperturbed (without the hole) situation and considers cylindrical reentrant holes of various diameters and depths. The two-dimensional nature of the hole is represented by a wall-streaming term which is used as a boundary condition for a reduced effective slab. The effective slab geometry is obtained by reducing the thickness of the original slab by an amount equal to the depth of the reentrant hole. The validity of this important simplification is confirmed by results of two-dimensional discrete ordinates transport calculations in which the reentrant hole is introduced explicitly. A second basic assumption used to simplify the numerical calculations is that the flux along the walls of the reentrant hole is adequately represented by the unperturbed flux. This approximation is judged valid by the success of the method in predicting experimental results. The analytical procedure is applied numerically using discrete S_n transport theory. Solutions are obtained from a code system which makes use of a standard production program DTF-IV as a subroutine for performing unperturbed and perturbed effective slab calculations. The calculational model yielded good predictions of the distorted fluxes for reentrant hole experiments performed on water at Rensselaer Polytechnic Institute. For fast neutron spec-

tra, the model predicted distortions (particularly at high energies) which were significant but not large enough to limit the viability of the experiment. 21 references. (auth)

11278 EXPERIMENTAL STUDIES ON NATURAL URANIUM–LIGHT WATER EXPONENTIAL PILE. 3. MEASUREMENT OF NEUTRON ENERGY SPECTRUM BY FOIL ACTIVATION METHOD. Kadotani, Hiroyuki; Takeda, Eiichi (Tokyo Inst. of Tech.). Tokyo Kogyo Daigaku Gakuho; No. 90, 67-75(Mar 1969).

Neutron energy spectrum was determined by measuring the cadmium ratio of BF_3 counter, Au and In foils. The measurements were performed on both multiplying and nonmultiplying systems. The multiplying system was the small exponential pile of Tokyo Institute of Technology. The nonmultiplying system was the homogeneous light water assembly poisoned by boric acid. The Cd-ratios were measured at the places where the Cd-ratio of BF_3 counter was constant. The thicknesses of In and Au foils were 100 mg/cm^2 and 40 mg/cm^2 respectively. The thickness of Cd cover was 0.5 mm. The measured Cd-ratios are listed. Results are described. (NSA of Japan)

11279 EXPECTED FUEL FABRICATION COSTS IN AN EXPANDING NUCLEAR ECONOMY. Gupta, D. (Kernforschungszentrum, Karlsruhe, Ger.); Fischer, K.-D.; Stephany, M. pp 297-314 of Economics of Nuclear Fuels. Vienna; International Atomic Energy Agency (1968).

From Symposium on Economics of Nuclear Fuels, Gottwaldov, Czechoslovakia, See STI/PUB-188; CONF-680541.

With the rapid growth of the nuclear industry in many industrialized countries, the requirement of the plant capacity for fabricated fuel elements will also grow fairly rapidly. Since the fabrication industry will have to meet, besides the running requirements, also the first-core requirements for the newly installed reactors within a year, its capacity at a given time will have to be much larger than the corresponding capacity for the reprocessing industry. The doubling time of the capacity for the fabrication branch of a nuclear industry is expected to be less than five years in the late 1970s and throughout the 1980s. As can be envisaged at present, with increasing commercialization of the nuclear power plants the number of reactor types that will be preferred by the electrical utilities will decrease also, leading to a certain amount of standardization of the fuel elements to be fabricated. The requirement of large capacities and standardization will favor increasing automation of the fabrication plants. The approximate fabrication cost trends for different plant sizes have been assessed for light water reactor and fast breeder fuels, after taking into account some of the important characteristics of an expanding nuclear industry. 3 references. (auth)

11280 THE PROPERTIES AND PERFORMANCE OF THE HOT NEUTRON SOURCE AT THE FR2 REACTOR. Abeln, O.; Drexel, W.; Glaeser, W.; Gompf, F.; Reichardt, W.; Ripfel, H. (Kernforschungszentrum, Karlsruhe, Ger.). pp 331-9 of Neutron Inelastic Scattering. Vol. II. Vienna; International Atomic Energy Agency (1968).

From Symposium on Inelastic Neutron Scattering, Copenhagen, Denmark. See STI/PUB-187(Vol.2); CONF-680501-(Vol.2).

For certain classes of neutron scattering experiments, it is desirable to increase the neutron intensity at energies above the Maxwellian peak of a reactor spectrum considerably. This can be done by installing a piece of moderator having a high temperature, a so-called hot source, at the tip of the beam tube. In the FR-2 experiments, graphite was used as material for the hot source. The possible gain in neutron intensity attainable with a hot source was studied in a mock-up experiment for various sizes and temperatures of the graphite block using the pulsed neutron technique. The agreement of the measurements with calculations was satisfactory. A plug carrying a graphite cylinder, 18 cm in diameter and 18 cm in height, was installed at the FR2 reactor. With proper thermal isolation, a graphite temperature of about 1700°K was reached by nuclear heating only. (auth)

11281 THE DESIGN AND PERFORMANCE OF THE HERALD COLD SOURCE. Davies, F. (Atomic Weapons Research Establishment, Aldermaston, Eng.); Rodgers, A. L.; Todd, M. C. J.; Ross, D. K.; Sanalan, Y.; Walker, J.; Belson, J.; Clark, C. D.; Mitchell, E. W. J.; Tuckey, G. S. G. pp 341-8 of Neutron Inelastic Scattering. Vol. II. Vienna; International Atomic Energy Agency (1968).

From Symposium on Inelastic Neutron Scattering, Copenhagen, Denmark. See STI/PUB-187(Vol.2); CONF-680501-(Vol.2).

A liquid hydrogen/deuterium cold source has been installed in one of the tangential beam tubes of the HERALD reactor. The design and construction of the refrigerator and cold source assembly are described and the operating experience is outlined. Measurements have been made of the neutron spectra from ambient sources and from cold sources using apparatus installed at both ends of the beam tube. On the long-wavelength apparatus for defect studies, the neutron spectra were measured in the range 6–15 Å using a mechanical velocity selector. At the other end of the tube, the inelastic neutron scattering apparatus was used to measure the neutron spectra between 4 and 8 Å using high resolution time-of-flight equipment. The total cold neutron intensity transmitted by the cold beryllium filter was also recorded on the latter apparatus. Initially, measurements were made on a series of ambient temperature sources to establish a reference point from which to estimate the overall gain and the gain as a function of wavelength. Measurements were also made on a number of mixtures ranging from 100% liquid hydrogen to 100% liquid deuterium. An optimum mixture has been found. The fluxes obtained from the cold source are 20 to 30 times greater than from ambient sources. The gain is independent of wavelength in the range 6–15 Å. By referring measurements on all mixtures to the flux from liquid hydrogen, comparisons are made with the results obtained by other groups. (auth)

11282 DESCRIPTION AND NEUTRON CHARACTERISTICS OF A NEUTRON GUIDING TUBE AT THE EL3 REACTOR. Farnoux, B.; Hennion, B.; Fagot, J. (CEN, Saclay, France). pp 353-80 of Neutron Inelastic Scattering. Vol. II. Vienna; International Atomic Energy Agency (1968). (In French).

From Symposium on Inelastic Neutron Scattering, Copenhagen, Denmark. See STI/PUB-187(Vol.2); CONF-680501-(Vol.2).

A neutron guiding tube can provide a more intense and better filtered beam of slow neutrons than the classical method (crystal filters). Such a device is under construction at the exit of a channel of the EL3 reactor in CEN Saclay. A short summary of the operating principles of a guiding tube is followed by the description of the mechanical and technical characteristics of the Saclay apparatus. This is a bent rectangular (20 mm × 50 mm) tube constructed from nickel mirrors. The radius of the curvature is 835 m, the total length of the tube is 30 m. The biological protection consists of a water pool 17 m long and 2 m × 2 m in cross section. The measurements have shown that the background at the experimental post is due to neutrons escaping through the imperfect reflecting surface of the tube; it could easily be eliminated by light shielding (Cd or Li). The neutron energy spectrum measured by the time-of-flight method at the exit of the tube confirmed the theoretical prediction: it contains only thermal and cold neutrons. The intensity distribution in a horizontal plane is homogeneous for cold neutrons (E < 5 MeV) and asymmetric for thermal neutrons (filter effect). The average neutron flux in the beam is 2.3×10^7 n cm^{-2} sec^{-1}. For cold neutrons, the transmission of the device is 95%. (auth)

11283 NEUTRON PULSE PROPAGATION IN A MULTIPLYING MEDIUM. Doshi, P. K. (Babcock and Wilcox Co., Lynchburg, Va.); Miley, George H. Nucl. Sci. Eng.; 39: 182-92 (Feb 1970).

A subcritical assembly (29 × 38 × 29 cm) built of TRIGA-type fuel elements was pulsed by coupling it with the Illinois TRIGA reactor through a graphite thermal column (2 ft square by 4 ft long). Flux measurements were made at seven locations in four different fuel loadings—9, 16, 25, and 49 fuel elements—with k_{eff} varying from ~0.4 to 0.92. A polynomial expansion method is used to provide a continuous representation of pulse shapes. Derivatives appearing in a diffusion-theory model, evaluated using this expansion, are then used to determine the propagation velocity and the neutronic parameters. The maximum "asymptotic" velocity (removed from the boundaries) varied from $\sim 4 \times 10^4$ cm/sec at $k_{eff} = 0.60$ to 2.54×10^4 cm/sec at $k_{eff} = 0.92$. The theoretical model involves an expansion which, depending on the number of terms retained, bounds the experimental data. However, differences of as much as 40% in absolute values are observed and they are attributed to inadequacies in the model for this small heterogeneous assembly. Uncertainties in the neutronic parameters, as well as nonlinearities in the instrumentation, may also contribute. 24 references. (auth)

11284 DEVICE FOR TRANSPORTING SAMPLE MATERIALS IN A TESTING REACTOR. Takahashi, Jiro (to Meidensha Electric Mfg. Co). Japanese Patent 1969-12637. 6 Jun 1969. Filed 27 Nov 1964.

The device proposed is for introducing into and withdrawing from a reactor core sample materials by means of a double-walled tube. In introducing it, liquid runs through the internal tube and comes out through the space between the two walls, and in withdrawing it, the direction is reversed. The method enables rapid change of the direction of liquid flow, thereby the sample material is cooled adequately. When a sample material in a capsule is sent into the reactor core, liquid flows through the inner tube, and comes out through the space between the walls;

this direction of liquid flow is maintained during irradiation. When withdrawing it from the core, the direction of liquid flow is reversed; that is, running in through the space between the walls and coming out through the internal tube. All the operation is done by means of valves. In addition to this usual system, a tank containing the liquid used in the system is installed; a pipe, connected to it, runs down to the outside space of the double-walled tube. When the direction of liquid flow is reversed the valve from the tank is opened and the liquid flows in the reversed direction. (NSA of Japan)

Rocket and Space Reactors

Refer also to abstracts 9492 and 9593.

11285 (AI-AEC-12850) SNAP 8 AUTOMATIC STARTUP AND PCS MERCURY INJECTION SIMULATION TESTS. Audette, R. F. (Atomics International, Canoga Park, Calif.). 31 Oct 1969. Contract AT(04-3)-701. 51p. Dep. CFSTI.

SNAP 8 reactor dynamic tests demonstrated the capability for fully automatic startup over eight decades from shutdown, and for automatically furnishing the heat load demand imposed by automatic startup of the flight system power conversion loop following reactor automatic startup. Test results are presented. Due to test limitations imposed by the ground test heat exchanger (IHX) in the heat rejection loop, reactor dynamics tests to the full predicted capability for the SNAP 8 Nuclear System were not performed. The heat exchanger was originally designed only for steady state heat transfer service. However, the tests performed approximate predicted flight system operation, and it can be reasonably extrapolated from the test results that the SNAP 8 reactor will provide the dynamic response characteristics required for the flight system. 9 references. (auth)

11286 (AI-AEC-12864) SNAP 8 DEVELOPMENT REACTOR NUCLEAR ANALYSIS. Swenson, L. D. (Atomics International, Canoga Park, Calif.). 31 Oct 1969. Contract AT(04-3)-701. 83p. Dep. CFSTI.

SNAP (Systems for Nuclear Auxiliary Power) reactors are intended primarily for use as lightweight reliable heat sources for production of electrical power in outer space. The S8DR (SNAP 8 Developmental-Reactor), the second SNAP 8 type to be constructed and tested, has a design goal of 12,000 hr of operation at 600 kwt, with NaK coolant temperatures of 1100°F inlet, 1300°F outlet. The reactor nuclear analyses are described including the determination of reactivity requirements, nuclear control requirements, material nuclear worths, and system excess reactivity. Comparison and normalization of analytical calculations with experimental results are discussed. Based on nuclear considerations, the calculations indicate that the reactor is capable of achieving its design goal with a considerable margin of operational capability. (27 references) (auth)

11287 NERVA: KEY TO DEEP SPACE FLIGHT. Wood, Nat; Aronson, Robert. Mach. Design; 41: 24-8(24 Jul 1969).

The Nerva nuclear engine project is reviewed, and characteristics of the engine compared with those of chemical engines. The earlier Kiwi and Phoebus projects are also discussed. The design and construction of the Nerva engine are described and illustrated. (TSS) (BBB)

Process Heat and Desalination Reactors

11288 (ORNL-TM-2451) A STUDY OF METALLIC URANIUM FUELED PRESSURIZED WATER REACTORS FOR THE PRODUCTION OF PROCESS HEAT OR ELECTRIC POWER. Anderson, Truman D.; Jones, J. E. Jr.; Podeweltz, C. M. (Oak Ridge National Lab., Tenn.). Dec 1969. Contract W-7405-eng-26. 237p. Dep. CFSTI.

An investigation was made of the applicability of metallic uranium fuels to pressurized-water reactors. Both process-heat and power reactors were considered, but the primary emphasis was on process-heat reactors suitable for single-purpose desalting. The results indicate that the use of metal fuel may lead to the development of an advanced converter that retains most of the system technology of present light-water reactors. Conversion ratios of about 0.9 were obtained for both process-heat and power reactors. The high conversion ratios achievable with metal fuel could lead to reduced fuel-cycle costs (~30% reduction relative to oxide fuel) and better utilization of ore resources and diffusion plant capacity. Several uncertainties must be resolved before metal fuel could become commercially useful. The most important of these uncertainties concerns the corrosion of uranium metal in water. Analyses of existing defected-element corrosion data indicate that an acceptably small amount of fuel would be corroded from a defective element if the reactor were shut down upon detection of the failure. The important point is, however, that the reactor would need to be shut down to limit the extent of fuel corrosion when a defect occurs. A reliable fuel-element is, therefore, a necessity for the successful exploitation of the potential advantages of metal fuel. (auth)

Marine and Portable Power Reactors

Refer also to abstract 9554.

11289 (GA-9486) PERFORMANCE OF THERMIONIC REACTORS FOR 50 TO 100 kWe. Homeyer, W. G. (Gulf General Atomic, Inc., San Diego, Calif.). Nov 1969. Contract AT(04-3)-167. 13p. (CONF-691024-1). Dep. CFSTI.

From IEEE Thermionic Conversion Specialist Conference, Carmel, Calif.

Four types of thermionic reactors for the 50 to 100 kW(e) power range were studied. The characteristics of these reactors are described and performance estimates for power plants containing them are given. All of the reactors contain the six-cell thermionic fuel elements (TFE) which are presently under development. Two reactors contain only thermionic fuel elements in the core. One of them, fueled with ^{235}U, is criticality limited, and has about twice as many thermionic cells as are necessary to produce 100 kW(e). With ^{233}U, the minimum critical reactor is in the 50 to 100 kW(e) power range. Reactors fueled with ^{235}U containing UN and U–ZrH driver fuel elements in addition to thermionic elements were also studied. All-cell reactors fueled with ^{233}U were shown to produce the lightest power plants in the 50 to 100 kW(e) power range. At 100 kW(e), power plants containing the ^{235}U all-cell reactor, the UN driver reactor, or the U–ZrH driver reactor are all comparable in weight. Driver reactors provide a lighter power plant than the all-cell ^{235}U reactor for power levels below 100 kW(e). 5 references. (auth)

Reactor Theory

Refer also to abstract 9705.

Kinetics

Refer also to abstracts 11172 and 11277.

11290 IMPROVEMENTS IN FAST REACTOR SPACE-ENERGY SYNTHESIS. Neuhold, R. J. (Babcock and Wilcox Co., Lynchburg, Va.); Ott, K. O. Nucl. Sci. Eng.; 39: 14-24 (Jan 1970).

The space-energy synthesis approach has been improved by employing reaction rate weighting, by the use of realistic trial functions, and by deriving a more general analytical solution for the synthesis equations which includes the necessary case of complex B^2. The use of reaction rates as weight functions and physically realistic trial functions made it possible to reduce the error of the space-energy synthesis method to such small values that its application in routine calculations of neutron spectra in fast reactors may be considered. The error reduction as compared to previous versions was typically a factor of 100 in δk and a factor of 20 in quantities which are sensitive to the nonseparability of space and energy. All cases with accurate results required a complex B^2 in the blanket region as compared to real B^2 for results with larger inaccuracies. 17 references. (auth)

11291 GENERALIZATION OF THE FINITE DIFFERENCE APPROXIMATION METHOD WITH AN APPLICATION TO SPACE–TIME NUCLEAR REACTOR KINETICS. Alcouffe, Raymond E. (Los Alamos Scientific Lab., N. Mex.); Albrecht, Robert W. Nucl. Sci. Eng.; 39: 1-13(Jan 1970).

An approximation method is developed which is applicable to the solving of integro-differential equations using a digital computer. This method is a generalization of the finite difference method in that information about the expected solution is added as trial solutions. This allows the possibility of significantly reducing the number of discrete mesh points necessary to achieve an accurate

solution over that required by the conventional finite difference method. The method is demonstrated on some space-time reactor kinetics problems. 8 references (auth)

11292 COMMENTS ON THE ITERATIVE APPROACH TO A SPACE–TIME NONLINEAR PROBLEM. Ibarra, H. (Philippine Atomic Energy Commission, Manila). Nucl. Sci. Eng.; 39: 130-1(Jan 1970).

Suggested corrections for E_c calculated by Shotkin are presented. Also, corrections related to orders of magnitude in derived equations are included. 3 references. (D.C.C.)

11293 EFFECTIVE EQUALLY LIMITING HOT CHANNELS IN REACTOR THERMAL DESIGN. Amendola, A. (Kernforschungszentrum, Karlsruhe, Ger.). Nucl. Sci. Eng.; 39: 121-3 (Jan 1970).

The exact general solution for effective equally limiting hot channels for a reactor with a cosine power distribution is presented. 3 references. (D.C.C.)

11294 DOPPLER BROADENING IN A MEDIUM WITH BOTH TEMPERATURE AND BOUNDARY MOTION. Perkins, S. T. (Univ. of California, Livermore, Calif.). Nucl. Sci. Eng.; 39: 25-31(Jan 1970).

Doppler broadening of neutron cross sections is described under the combined influence of temperature and boundary motion. The effective cross section is explicitly presented for the two cases of a constant speed, isotropic boundary motion (which is identical to the condition of an isotropic neutron flux), and also a constant speed, monodirectional boundary motion. The functional relations interconnecting the effective cross section at different temperatures and boundary motion velocities are pointed out. The results of numerical calculations are also presented. 13 references. (auth)

11295 DOPPLER EFFECT STUDIES USING MULTILEVEL FORMALISM. Hwang, R. N. (Argonne National Lab., Ill.). Nucl. Sci. Eng.; 39: 32-49(Jan 1970).

Some quantitative results in both the resolved and the unresolved resonance regions are presented. Detailed discussions on the interpretation and analysis of these results are given. Some further studies on the statistical behavior of the S-matrix parameters with the emphasis on the residues are described. Both theoretical predictions and numerical results for cases pertinent to the reactor Doppler-effect analysis are given. 20 references. (auth)

11296 CONSTRUCTION OF LYAPUNOV FUNCTIONS FOR NONLINEAR REACTOR STABILITY STUDIES. Pai, M. A.; Sastry, V. R.; Ananda Mohan, M. (Indian Inst. of Tech., Kanpur). Nucl. Sci. Eng.; 39: 105-7(Jan 1970).

A systematic derivation of the Lyapunov function using Kalman's construction procedure is presented. A method for using the Lyapunov function so constructed for the determination of the stability domain of the reactor is also given. The method proposed is general enough to be applicable to higher-order nuclear reactor models with more than one temperature coefficient. This is demonstrated by application to a reactor model with two temperature coefficients. 8 references. (auth)

11297 REPLY TO COMMENT ON THE ITERATIVE APPROACH TO A SPACE–TIME NONLINEAR PROBLEM. Shotkin, Louis M. (Brookhaven National Lab., Upton, N. Y.). Nucl. Sci. Eng.; 39: 131-3(Jan 1970).

11298 COMMENTS ON THEORETICAL AND EXPERIMENTAL CRITERIA FOR REACTOR STABILITY. Di Pasquantonio, F. (ENEL, Milan); Kappel, F. Nucl. Sci. Eng.; 39: 133-4(Jan 1970).

11299 COMMENTS ON THE NEUTRON TRANSPORT THEORY WITH ANISOTROPIC SCATTERING. Thielheim, K. O.; Claussen, K. (Univ., Kiel). Nucl. Sci. Eng.; 39: 134-5(Jan 1970).

One-group neutron transport with anisotropic scattering in a homogeneous medium is shown to have no discrete eigenvalues of the transformed transport equation within the region of continuous eigenvalues. (auth)

11300 DYNAMIC OF POWER REACTOR. Gotoh, Yorio; Koyama, Kinji (Japan Atomic Energy Research Inst., Ibaraki). J. Nucl. Sci. Technol. (Tokyo); 6: 707-10(Dec 1969).

A method is proposed for obtaining the power spectral density in a steady-state power reactor with randomly varying reactivity not involving neutron flux changes. 4 references. (H.D.R.)

11301 LATTICE DEPENDENCE OF THE EQUIVALENCE RELATION. Chiarella, Carl (Univ. of New South Wales, Wollongong). J. Nucl. Sci. Technol. (Tokyo); 6: 703-6(Dec 1969).

An equivalence relation which extends and incorporates into the rational approximation the basic ideas of some Russian workers is derived. This equivalence relation takes accurate account of the dependence on the Dancoff correction. The narrow resonance approximation is assumed throughout. 8 references (auth)

11302 INTERPRETATION OF PULSED-NEUTRON-SOURCE EXPERIMENTS IN A MULTIREGION REACTOR. Amano, Fumio (Electrotechnical Lab., Tokyo). J. Nucl. Sci. Technol. (Tokyo); 6: 689-97(Dec 1969).

By expanding the static flux into kinetic fluxes containing the fundamental and higher modes, a kind of inhour equation is derived which can express kinetic distortion, and can relate the static reactivity to prompt decay constants and to kinetic and adjoint fluxes. The equation is developed using the time-dependent, multigroup diffusion approximation, and is applied to the interpretation of pulsed-neutron-source experiments in a multiregion reactor. It is shown from this application that the Simmons–King formula can express the dynamic reactivity only under conditons of constant generation time and no kinetic distortion, and that the conventional inhour equation derived by the perturbation method cannot distinguish between the static and dynamic reactivities differing from each other on account of kinetic distortion. 18 references. (auth)

11303 AN ADJOINT-WEIGHTING IN NEUTRON FLUCTUATION ANALYSIS WITH EMPHASIS ON AN EFFECTIVE DETECTOR EFFICIENCY. Congdon, M. E.; Albrecht, R. W. (Univ. of Washington, Seattle). Nucl. Sci. Eng.; 39: 207-14(Feb 1970).

A set of fundamental equations for fluctuations about the mean neutron density is studied for a reactor-detector system in which the detector is treated as an integral part of the system. The reactor-detector system is described, mathematically, as a general Markov process, and expressions for various descriptive parameters are derived in a consistent manner within the context of the basic equations. The role of the general adjoint neutron density is discussed with special emphasis on the mean and second-moment functions, and a relationship between the second-moment equations similar to the relationship between first-moments (mean and its adjoint) is observed. The extension to higher moments is also noted. A reduction of the second-moment equations is carried out, without approximation, using a variational principle. This consistent reduction allows a definition of the parameters involved, especially a definition of the detector efficiency, through a comparison of this reduced form with the usual point-reactor equations. The parameters defined contain weighting functions dependent upon the number of detectors used in the experiment. 18 references. (auth)

11304 APPLICATION OF VARIATIONAL SYNTHESIS TO THE OPTIMAL CONTROL OF SPATIALLY DEPENDENT REACTOR MODELS. Stacey, W. M. Jr. (Knolls Atomic Power Lab., Schenectady, N. Y.). Nucl. Sci. Eng.; 39: 226-30(Feb 1970).

The methods of variational synthesis, which are derived from the direct method of the calculus of variations, are applied to the problem of computing the optimal control for spatially dependent reactor models. By this means, the optimal control problem is reduced to the solution of coupled algebraic equations. A general formalism is developed which is specialized to the case of one-group neutron diffusion theory, with and without delayed neutrons, and with thermal feedback. 9 references. (auth)

11305 ON THE USE OF POINT KINETICS FOR THE ANALYSIS OF ROD-EJECTION ACCIDENTS. Yasinsky, J. B. (Westinghouse Electric Corp., West Mifflin, Pa.). Nucl. Sci. Eng.; 39: 241-56(Feb 1970).

The results of a numerical study as to the adequacy of the point kinetics method for analyzing rod-ejection accidents are presented. Two-group slab representations of three different seed-blanket reactors are considered. Five different point kinetics formulations are considered for each fictitious rod-ejection accident considered; each formulation being characterized by the shape functions used to calculate the instantaneous reactivity. From these numerical studies it is concluded that the accuracy of a point model, for rapid, nonseparable transients of the type considered, is extremely dependent upon the specifics of the particular model (i.e., on the shape function used), and in general one cannot assume a priori that a specific point model is conservative or nonconservative. 7 references. (auth)

11306 INTEGRAL TESTS OF ENDF/B AND GAM NEUTRON CROSS-SECTION DATA IN A CLEAN FAST ASSEMBLY. Moore, R. A.; Sargis, D. A.; Cohen, S. C. (Gulf General Atomic Inc., San Diego, Calif.). Nucl. Sci. Eng.; 39: 263-72(Feb 1970).

An extensive series of reactivity worth measurements designed

to check the validity of basic cross section data on an integral basis is described. The critical assembly was composed of blocks of slightly diluted fuel (93.2% enriched U and polyethylene) stacked into a cuboidal configuration. Measurements are compared to predictions based upon ENDF/B and GAM data and good agreement is found for most materials examined. 18 references. (H.D.R.)

11307 TRANSIENT SOLUTIONS OF THE NEUTRON SLOWING DOWN EQUATION. Williamson, T. J. (Naval Postgraduate School, Monterey, Calif.). Nucl. Sci. Eng.; 39: 273-7(Feb 1970).

A family of analytical solutions that describe the time-dependent slowing down of neutrons in infinite media are presented. The solutions are valid over most of the transient region. 12 references. (H.D.R.)

11308 A VARIATIONAL REBALANCING METHOD FOR LINEAR ITERATIVE CONVERGENCE SCHEMES OF NEUTRON DIFFUSION AND TRANSPORT EQUATIONS. Nakamura, Shoichiro (Hitachi, Ltd., Japan). Nucl. Sci. Eng.; 39: 278-83 (Feb 1970).

An improvement on the variational rebalancing method is presented in which a different type of partitioning is used. The principle of the method is described by defining a coarse mesh system and a modified pyramid function. The effect of the variational rebalancing is studied using a simple one-group one-dimensional diffusion equation as a model. The method is then applied to two-dimensional diffusion equations and to DS_n iterations. 7 references. (H.D.R.)

11309 VALIDITY OF SOME APPROXIMATE ZERO-POWER DESCRIBING FUNCTIONS. Vaurio, J. K.; Pulkkis, G. (Technical Univ. of Helsinki). Nucl. Sci. Eng.; 39: 283-5(Feb 1970).

Some reactor kinetics equations approximate describing functions derived previously are defined. These describing functions are compared with each other and with the transfer function. 6 references. (H.D.R.)

11310 ANISOTROPIC DIFFUSION THEORY. Michelini, M. (CNEN, Rome). Energ. Nucl. (Milan); 16: 700-8(Nov 1969).

The possibility of a correct neutron flux prediction (under the classic diffusion assumptions) by means of a general formulation of two diffusion coefficients ($D_{||}$ and $D_{\perp}$) in each region is analyzed. This possibility is pointed out deriving general definitions of these coefficients. A simple interpretation of the coexistence of two diffusion coefficients is also given. Numerical comparisons with the S_n method and with the classic diffusion are given, which prove the better accuracy of the anisotropic diffusion. 6 references. (auth)

Dynamics

11311 (EURFNR-682) RADYVAR: PROGRAM FOR THE PROCESSING OF THE PLACE-DEPENDENT DYNAMICS OF FAST BREEDER REACTORS WITH THE AID OF THE KANTOROWITSCH VARIATION PROCESS. Kessler, G. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Reaktorentwicklung). Translation of report KFK-781/2. 84p. Dep. CFSTI.

Work Performed under United States-Euratom Fast Reactor Exchange Program.

The theory for the solution of place-dependent dynamics equations for fast breeder reactors by means of a variation principle was described in KFK 781, Part I. The requisite calculating procedures and the calculating program available are presented. The calculation of the nonsteady power and temperature field patterns in the cylinder-symmetrical reactor is taken from the RADYVAR (place-dependent dynamics of fast reactors with use of a variation process) program. RADYVAR is written in FØRTRAN II for the IBM 7094 and exists in two versions: RADYVAR 2 processes $P_k \leq 2$ estimate functions; RADYVAR 3 processes only $P_k = 3$ estimate functions per macro-interval Δt_k. A program version for more than three estimate functions is not necessary, since the same effect can be attained by shortening the macro-interval Δt_k. (auth)

Experimental Applications

Refer also to abstracts 11170 and 11268.

11312 (AEEW-M-154) RESONANCE CAPTURE IN ^{240}Pu. PART I. BERYLLIA MODERATED SYSTEMS. Askew, J. R. (Atomic Energy Establishment, Winfrith (England)). Reissued Aug 1969. 27p. Dep. CFSTI (U. S. Sales Only).

A numerical method for calculating captures of the 1 eV resonance of ^{240}Pu is described. Resonance escape probabilities and temperature coefficients are calculated for a range of homogeneous mixtures of this absorber and BeO at 300 and 1500°K. Resonance escape probabilities for two cell configurations are also obtained for 1500°K. The programs (for the MERCURY computer) used in this work are also described briefly. 9 references. (auth)

11313 (AEEW-M-155) RESONANCE CAPTURE IN ^{240}Pu. PART II. GRAPHITE MODERATED SYSTEMS. Askew, J. R. (Atomic Energy Establishment, Winfrith (England)). Reissued Aug 1969. 16p. Dep. CFSTI (U. S. Sales Only).

Resonance escape probability and effective cross sections for the 1 eV resonance of ^{240}Pu are calculated for a range of homogeneous mixtures of this absorber with graphite at temperatures of 300° and 1500°K. Separate fuel and moderator contributions to the temperature coefficient are calculated for these homogeneous systems. Resonance escape probability at 1500°K is calculated for some simple cell geometries, and the effects of small changes in geometry are demonstrated. A particular case of spatial burn-up is considered, and the change in resonance escape with burn-up is compared to that calculated assuming the material to be uniformly spread across the absorbing region. (auth) (UK)

11314 (AEEW-M-236) RESONANCE CAPTURE IN ^{240}Pu. PART III. PLUTONIUM CARBIDE PARTICLES IN A GRAPHITE MATRIX. Askew, J. R.; Carpenter, G. M. (Atomic Energy Establishment, Winfrith (England)). Reissued Aug 1969. 17p. Dep. CFSTI (U. S. Sales Only).

The effective energy-dependent cross sections of ^{240}Pu in PuC particles are determined using a simple collision probability argument, an approximation applicable to a range of concentrations of such particles in a graphite matrix. The resonance escape probability at temperatures of 300 and 1500°K is then calculated for a mixture of infinite extent and the temperature coefficient deduced. Resonance capture in such systems is shown to be considerably reduced by the use of a fuel in particle form. (auth) (UK)

11315 (BNWL-1203) EGGNIT: A MULTIGROUP CROSS SECTION CODE. Richey, C. R. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Nov 1969. Contract AT(45-1)-1830. 65p. Dep. CFSTI.

The EGGNIT code has been developed to generate multigroup constants for neutron diffusion and transport calculations. This code is a major revision of the GAMTEC-II code. Most of the revisions were made in the resonance theory treatment where the added Nordheim numerical integration method permits treating absorbers and admixed scatterers exactly. An iteration technique is utilized to extend Nordheim's method to multiregion and other complex geometries. Other added features in EGGNIT are: interference absorption due to a nearby resonance line is permitted, interference scattering is included, resonance absorption integral contributes to the absorption of several GAM-I fine groups, and Dancoff shielding correction is computed for either square or hexagonal lattices by Carlvik's DASQUE program. 17 references. (auth)

11316 (EURAEC-2125) SUBCRITICAL EXPERIMENTS. Topical Report No. 12. Debrue, J.; Delrue, R.; Rotter, W.; Van Deyck, D. (Centre d'Etude de l'Energie Nucleaire, Brussels (Belgium). Societe Belge pour l'Industrie Nucleaire, Brussels). Aug 1969. Contract 001-64-1-TRUB. 94p. (EUR-4013; BN-6908-3). Dep. CFSTI.

Work performed under United States-Euratom Joint Research and Development Program.

Two series of subcritical experiments performed at Mol from 1965 to 1967 are described. Both series of measurements employed ^{235}U-enriched UO_2 fuels in light water moderated lattices to provide supporting data for subsequent plutonium recycling studies. Measurements in 5% ^{235}U-enriched lattices determined the prompt decay constant and the reactivity in various types of lattices. Measurements in 7% ^{235}U-enriched lattices determined the reactivity and decay constant in highly reflected assemblies. The various measurement techniques and analysis methods used are evaluated, and detailed results of the measurements are presented. (H.D.R.)

11317 (FMRB-28/69) A COMPUTER PROGRAM FOR THE SOLUTION OF THE ONE-DIMENSIONAL DIFFUSION EQUATION FOR NEUTRONS WITH SEVERAL ENERGY GROUPS IN THREE-ZONE ARRANGEMENTS OF VARIOUS MATERIALS (EINDIF). Schweer, H.-H. (Physikalisch-Technische Bundesanstalt, Brunswick (West Germany)). May 1969. 21p. (In German). Dep. CFSTI (U. S. Sales Only).

The multiplication factor for neutrons (k_{eff}) in a reactor configuration is computed approximately by a code based on diffusion theory. The one-dimensional EINDIF code is prepared for several energy groups and three material regions. The code, written in programming language ALGOL, may be applied to a single package containing fissile material and to an assembly of packages. 3 references. (auth)

11318 (GAMD-8718) ONE-GROUP TWO-DIMENSIONAL CRITICAL SIZE PREDICTION SUBROUTINE. Mathews, D. R. (Gulf General Atomic, Inc., San Diego, Calif.). 23 May 1968. Contract AT(04-3)-167. 26p. Dep. CFSTI.

A one-energy group diffusion theory subroutine has been developed to predict critical sizes of reflected finite cylindrical reactors for use in parametric surveys. An iteration between axial and radial one-dimensional reflected calculations is performed to estimate the critical size. (auth)

11319 COMPARISON OF METHODS FOR DETERMINING MODERATOR LEVEL REACTIVITY COEFFICIENTS. Wennemo-Hanssen, S. E. (Institutt for Atomenergi, Kjeller, Norway). Nucl. Sci. Eng.; 39: 107-9(Jan 1970).

Knowledge of the moderator reactivity coefficient $\partial\rho/\partial h$ is useful in many cases where small reactivity effects, for instance due to changes in temperature, are accurately determined. Four methods for measuring the moderator reactivity coefficient in H_2O or D_2O moderated reactor systems have been investigated and compared. 4 references. (auth)

11320 CONTROL ROD PROGRAMMING OPTIMIZATION USING DYNAMIC PROGRAMMING. Terney, William B.; Fenech, Henri (Massachusetts Inst. of Tech., Cambridge). Nucl. Sci. Eng.; 39: 109-14(Jan 1970).

Dynamic programming and a direct flux-synthesis method are used to determine the optimal control-rod program which minimizes power peaking throughout life in a representative pressurized-water reactor (PWR). (Other optimization criteria could be used in an analogous fashion.) First, the optimization criterion is formulated and dynamic programming is used to write the recursion algorithm. The direct-synthesis method is applied to the flux and criticality problem. Then the analytical and physical models are established and the procedures used to obtain the optimal policy. The results indicate that dynamic programming does significantly reduce the number of calculations required. Some error and sensitivity considerations are also included. 8 references. (auth)

11321 SURFACE MULTIPLICATION. Wilson, R. E. (Univ. of Washington, Seattle); Hall, R. J.; Clayton, E. D. Nucl. Sci. Eng.; 39: 119-20(Jan 1970).

A brief review of the development and accuracy of surface multiplication criticality parameters is presented. Calculated and experimental values for surface multiplication are compared. 3 references. (D.C.C.)

11322 A THEORY OF CONTROL-ROD PROGRAMMING OPTIMIZATION IN TWO-REGION REACTORS. Motoda, Hiroshi; Kawai, Toshio (Central Research Lab., Hitachi, Japan). Nucl. Sci. Eng.; 39: 114-18(Jan 1970).

The coupled effect of the control-rod programming and the fuel burnup is interpreted, geometrically, by the trajectory drawn in the burnup space. Some conventional rod programmings are discussed and compared. The problem of optimizing the control-rod programming to maximize the fuel burnup with the constraint imposed on the hot spot factor is formulated and solved for a typical boiling water reactor (BWR). The method of Maximum Principle is applied to the two-region bare reactor; and it has been assumed that the radial and the axial power distribution are separable within the validity of one-group diffusion approximation. 5 references. (auth)

11323 STATISTICAL TEMPERATURE DISTRIBUTION CALCULATION IN PEBBLE-BED REACTORS. Massimo, L.; Schmid, U. A. (Brown Boveri/Krupp Reaktorbau GmbH, Mannheim, Ger.). Nucl. Eng. Design; 10: 367-72(Jul 1969).

In high temperature gas-cooled pebble bed reactors a meaningful way of describing the fuel element temperature is a statistical distribution function. Such a function gives information from which fuel element damage and fission product release can be assessed. A numerical method for the calculation of this statistical temperature distribution has been developed taking into account the flow properties of the pebble bed. Results are given for the 300 MW(e) THTR reactor. For this reactor statistical distributions have been calculated for the temperature throughout the fuel, for the surface temperature of the fuel compact, and for the temperature difference from the center to the surface of the fuel compact. (4 references) (auth)

11324 EFFECTS OF BUCKLING CALCULATION ON DIFFUSION PARAMETER MEASUREMENTS FOR HEAVY WATER IN SPHERES. McGhee, B. W.; Haroon, M. R.; Graham III, W. W. (Georgia Inst. of Tech., Atlanta). Nucl. Instrum. Methods; 76: 342-8(1969).

The neutron diffusion parameters of heavy water were determined from measurements taken in spherical aluminum shells with use of the pulsed neutron source method. The decay of the neutron population was monitored using a multichannel analyzer, with a 10 μsec channel width, and a ^3He detector positioned at two locations within each sphere. The time-asymptotic decay constant for each sphere was calculated from the experimental data using the channel-dropping method. Values of the geometric buckling were calculated using the average sphere radius, with a wall-thickness correction, and two methods of calculating the extrapolation length. These methods were based on the formulations used by Dorning (method D) and Elkert (method E). This resulted in two values of the buckling for each sphere. Temperature and purity corrections were made to the decay constants, and the diffusion parameters were obtained by fitting to the customary expansion for the decay constant in the buckling. The results are presented. 15 references. (auth)

Reactor Components, Fuels, and Accessories

Refer also to abstracts 9429, 9434, 9461–9463, 9548, 9557–9562, 9569, 9570, 9572, 9576, 9590, 9591, 9609–9612, 9614, 9615, 9624, 9626, 9706, 9710, 9728, 9984–9988, 9991, 9997, 10004, 10006, 10012–10014, 10029, 10034, 10035, 10041, 10044, 10077, 10079, 10120, 10121, 10127, 10134, 10138, 10140–10142, 10147, 10151–10153, 10156, 10157, 10160, 10164, 10165, 10167, 10168, 10185, 10188, 10189, 10191, 10193, 10195, 10196, 10202–10205, 10207–10212, 10218, and 11104.

11325 (CEA-R-3888) CONTRIBUTION TO THE STUDY OF THE FISSION-GAS RELEASE IN METALLIC NUCLEAR FUELS. Kryger, Bernard (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Oct 1969. 85p. (In French). Dep. CFSTI (U. S. Sales Only).

In order to study the effect of an external pressure on the limitation of swelling due to fission-gas precipitation, some irradiations have been carried out at burn-ups of about 35,000 MWd/ton, and at average sample temperatures of 575°C, of non-alloyed U and Mo–U in a thick stainless steel can. A cylindrical central hole allows a fuel swelling from 20 to 33 per cent according to the experiment. After irradiation, the U samples showed two types of can rupture: the one is due to the fuel swelling, and the other, to the pressure of the fission gases, released through a network of microcracks. The cans of the Mo–U samples are all undamaged, and it is shown that the gas release occurs by interconnection of the bubbles for swelling values higher than those obtained in the case of U. For each type of fuel, a swelling-fission gas release relationship is established. (30 references) (auth)

11326 FLUIDIC ACTUATED CONTROL ROD DRIVE SYSTEM. Ripley, Charles C. (to United States Atomic Energy Commission). U. S. Patent 3,486,975. 30 Dec 1969.

A hydraulically actuated piston for regulating a control rod is described. The control rod is raised and lowered inside a cylindrical tube in the core of a nuclear reactor by the pressure of an electrically conductive fluid from one of two outputs of a fluidic amplifier valve. An electromagnetic pump associated with the fluidic amplifier valve controls the flow of electrically conductive fluid by diverting it to the cylindrical tube containing the piston and control rod. (AEC)

11327 STABILITY IMPROVEMENT FOR NUCLEAR REACTOR AUTOMATIC CONTROL SYSTEM. Sparks, David W.; Tessier, Jack H. (to United States Atomic Energy Commission). U. S. Patent 3,483,081. 9 Dec 1969.

A reactor servo control method is described in which an instantaneous physical measure of the difference between a desired function of power level and the same function of the actual measured power level is obtained and applied as an error signal to control element drives to cause the control elements to move at a velocity corresponding to the magnitude and sense of the error signal. The error signal is multiplied before application to the control element motive means by a factor $[(\beta - k_{ex}(1 - \beta)]$ where

β is the delayed neutron fraction and k_{ex} is the excess multiplication factor. (AEC)

11328 IMPROVEMENTS IN MONITORING NUCLEAR REACTOR FUEL ELEMENTS. Cartwright, David Kendall; Bishop, John (to United Kingdom Atomic Energy Authority). British Patent 1,173,345. 10 Dec 1969. Filed 30 Jun 1967.

Apparatus is described for monitoring reactor fuel elements for leakage, operating in conjunction with a number of sample streams. The apparatus comprises a stack of alternate working and shielding layers, with at least two working layers, two arrays of detectors, and an array of sample chambers positioned in each working layer. The number of sample chambers in each working layer is less than the number of detectors in the layer. Each detector is adapted to provide a distinctive output signal, depending on whether or not it detects activity in a sample stream. A sample stream can be fed continuously into and out of each chamber, each detector being simultaneously scanned for activity signals. Signals from at least three detectors serve to define a chamber uniquely. Each shielding layer serves to attenuate passing from sample chambers in one working layer to detectors in another working layer. Various alternative arrangements of working and shielding layers, detectors, and sample chambers are described. (UK)

11329 AN IMPROVED SEALING PLUG FOR A NUCLEAR REACTOR. West, Derek; Dearden, Ronald Austin; Talor, Donald Garden (to United Kingdom Atomic Energy Authority. Flight Refuelling Ltd.). British Patent 1,171,620. 26 Nov 1969. Filed 28 Mar 1966.

A metallic sealing plug and standpipe combination for a nuclear reactor is described which includes means for sealing one end of the standpipe utilizing a lip on the plug extending longitudinally from the end of the standpipe and engaging a corresponding surface in the bore of the standpipe. The external surface of the lip or the corresponding surface in the bore of the standpipe is cylindrical, while the complementary surfaces are tapered. Prior to assembly of the lip the maximum and minimum radial dimensions of the tapered surface are respectively greater and less than the radius of the cylindrical surface. Latch means are provided having at least three latch members movable radially outwardly of the plug in a direction normal to the longitudinal axis of the plug. (UK)

11330 BOOSTER ROD OR SAFETY ROD INSTALLATION. Charles, Robert; Bouchet, Bernard (to European Atomic Energy Community). British Patent 1,175,388. 23 Dec 1969. Priority date 16 Dec 1966, Belgium.

REACTOR CONTROL ELEMENTS—drives for, description of dual phase operating and scram (D.C.C.)

11331 NUCLEAR FUEL-ELEMENT. Lass, James Lloyd (to General Electric Co.). British Patent 1,173,928. 10 Dec 1969. Priority date 26 Jan 1966, United States.

REACTOR FUEL ELEMENTS—design parameters for tube shaped Type 304 stainless steel insulated pellet type (D.C.C.)

11332 TESTING FOR FUEL ELEMENT SHEATHING FAILURES IN NUCLEAR REACTORS. Duncombe, Edward; Davidson, Daniel Fraser; Wright, James Rostron (to United Kingdom Atomic Energy Authority). British Patent 1,175,836. 23 Dec 1969. 22 Apr 1966.

Reference is made to fuel element failures in liquid metal cooled reactors. In such reactors there is normally very little pressurization of the coolant, and consequently on the outlet side of the core, whence samples have to be taken for examination for fission products, there may be insufficient pressure head to obtain the requisite flow through the small bore sampling pipes. The system described is based on coupling a sampling pipe in a magnetic field in such a manner with a stream of core coolant that a sample flow is drawn through the sampling pipe by an electromagnetic pumping effect. Various alternative arrangements of sampling pipes, fission product detectors, permanent magnet assemblies, pumps, coolant stream ducts, heat exchangers, etc., are described. (UK)

11333 IMPROVEMENTS RELATING TO NUCLEAR REACTOR FUEL ELEMENTS. Linning, David Lees; Clough, Roy (to United Kingdom Atomic Energy Authority). British Patent 1,174,575. 17 Dec 1969. Filed 23 Dec 1965.

Reference is made to fast reactor ceramic fuel elements and means adopted to accommodate fuel swelling in such elements and thus to prevent sheathing failure. In the fuel element described the fuel has an aggregate density less than the maximum theoretical density in order to include distributed voidage. A solid interlayer is disposed between and directly contacting the sheathing and the fuel, this interlayer containing fertile atoms but being depleted in fissile atoms relative to the fuel, and having thermal insulating properties so as to increase the operating temperature of the fuel and thus lower its compressive creep resistance, in order to enable absorption of the irradiation induced swelling in the voidage. Whereas the fuel may contain Pu-atoms, the interlayer may comprise as its sole source of fissile atoms a ceramic uranium compound of natural or depleted abundance. The interlayer may have a thickness such that when the element is operating at the design heat output rating the temperature at the adjoining fuel surface is at least 1000°C in the region of maximum burn-up. (UK)

11334 FEATURES OF THE ZONAL CHARACTERISTICS OF A γ-RADIATION DETECTOR, INTENDED FOR ACTIVATION MEASUREMENTS OF REACTOR CHARACTERISTICS. Bushuev, A. V.; Yurova, L. N. At. Energ. (USSR); 27: 458-9(Nov 1969). (In Russian).

The averaged cross sections of nuclear reactions are often employed to estimate certain reactor parameters. The neutron flux and spectrum are often not constant and their change affects the reaction rates; therefore, the radioactive products of the reactions may be unevenly distributed within an irradiated foil. In order to determine the true course of the reaction, a correction must be provided to compensate for the nonuniform zonal characteristics of the reactor. Methods are available to design reactors with a uniform surface sensitivity. It is preferable to carry out the measurements under such conditions that the results will be independent of the distribution of the radioactive products in the foil, instead of making corrections for the zonal characteristics of the detector. However, preparation of a uniform source usually lowers the accuracy of the measurements. (TTT)

11335 EXPERIMENT ON THE HIGH-STRESS FATIGUE AT THE NOZZLE POSITION OF A REACTOR PRESSURE VESSEL. 2. Kameoka, Toshio; Sato, Eiichi (Kobe Steel Works, Ltd., Japan). Kobe Seiko Giho; 19: 102-10(Apr 1969). (In Japanese).

The present experiment was performed as a part of the series of studies to give basic information on the design of a reactor pressure vessel. It included the following: high-stress fatigue tests of through- and flush-type nozzles at different pressures; strain behavior at the corner-position of a flush-type nozzle; relation with the results of other tests for nozzle materials; relation with Langer's and Manson's formulae; and relation with the allowable stress in ASME SEC III. Results are presented. (NSA of Japan)

11336 PRESTRESSED CONCRETE PRESSURE VESSEL FOR NUCLEAR REACTOR THERMAL DESIGN AND ANALYSIS. Ando, Tetsuya; Mochizuki, Masao (Fuji Electric Co., Tokyo). Fuji Jiho; 42: 522-30(Jun 1969). (In Japanese).

The prestressed concrete pressure vessel (PCPV) has been used in Magnox reactors and AGR's. The PCPV has less problems in technology compared with steel vessel, when they are applied to large reactors, and it is superior in economy and safety. Therefore, plans are being made for using the PCPV for light-water reactors. The design requirements consist of keeping concrete temperature below the permissible level, eliminating excessive thermal stress combined with internal pressure, etc., and preventing excessive concrete creep. The thermal design of PCPV's is first outlined, and then the calculation program for analysis of temperature distribution in the PCPV is explained. In connection with the thermal design, heat insulation and removal in the PCPV, various insulating materials, and systems of heat insulation and removal, are described. The calculation program for analysis of the PCPV temperature distribution was prepared by the finite element method, to evaluate effects of heat insulation and removal. Comparing with theoretical values, high accuracy and calculation-speed, and the effectiveness in abnormal cases were confirmed. Finally, change in temperatures in a loss-of-coolant accident is described. (NSA of Japan)

11337 SAFETY ROD SYSTEMS FOR NUCLEAR REACTORS. Agazzi, Alberto; Broggi, Armando; De Paratesi, Serigo Galli; Ghiurghi, Luciano (to European Atomic Energy Community). British Patent 1,177,895. 14 Jan 1970. Priority date 26 Oct 1967, Belgium.

REACTOR CONTROL ELEMENTS—design parameters for valve regulated liquid (D.C.C.)

11338 DISMANTLING FUEL ELEMENT STRINGS FOR NUCLEAR REACTORS. Cook, Reginald Kenneth (to Nuclear Design and Construction Ltd.). British Patent 1,176,565. 7 Jan 1970. Filed 1 Jun 1967.

Reference is made to fuel element assemblies in the form of strings, each string comprising a number of fuel elements supported on a tie bar connected to a standpipe shield plug. The use of cutting machines for breaking down such assemblies, or subjection of the tie bars to shear stress until they break, is unsatis-

factory due to the hardness of the materials involved (such as Nimonic). In the dismantling method described controlled intense heat is applied inductively to the point on the tie bar where it is required to be parted from its shield plug, so as to approach the melting temperature, and stress is applied to the tie bar so as to part it from the shield plug. A similar procedure may be adopted for breaking the tie bar into sections for disposal. A dismantling facility may be provided comprising a containment vessel, means for supporting the fuel elements so as to permit relative movement between them and the tie bar and to uncover a length of the latter at a selected point for dismantling. A magazine may be provided for receiving separated lengths of the tie bar. (UK)

11339 IMPROVEMENTS IN OR RELATING TO ROD ACTUATING SYSTEMS FOR NUCLEAR REACTORS. Hanson, Douglas Oliver (to Nuclear Power Group Ltd.). British Patent 1,176,638. 7 Jan 1970. Filed 30 Nov 1967.

The system described relies on the rods being inserted into the reactor core by means of an external force produced by a falling weight or weights, this force being transmitted to the rods by a pulley and continuous rope or chain system. A separate actuating mechanism may be provided for each rod. The force raising each rod may be produced by two falling weights and the mechanism may incorporate a stop for arresting one of the weights while allowing the other to continue falling and a second stop spaced from the first which arrests the second weight, thereby reducing the force acting to move the rod after a predetermined travel. The rods will normally be inserted vertically upwards into the reactor. (UK)

GENERAL

11340 (ANL-Trans-794) ELECTRON DIFFRACTION STUDY OF THE STRUCTURE OF CADMIUM IODIDE. Punnsker, Z. G. Translated for Argonne National Lab., Ill., from Zh. Fiz. Khim.; 15: 559-76(1941). 34p. Dep. CFSTI.

11341 (BMI-171-124) LIMNOLOGY STUDIES, AMCHITKA ISLAND, ALASKA. Annual Progress Report, FY 1969. Amchitka Bioenvironmental Program. Koob, Derry D. (Battelle Memorial Inst., Columbus, Ohio). 1 Aug 1969. Contract AT(26-1)-171. 32p. Dep. CFSTI.

11342 (BNL-tr-293) ON THE FEASIBILITY OF PROSPECTING FOR VARIOUS GENETIC TYPES OF QUARTZ VEINS USING THE PIEZOELECTRIC METHOD. Mullerbeck, A. G.; Neistadt, N. M. Translated by Stephen J. Amoretty (Brookhaven National Lab., Upton, N. Y.), from Dokl. Akad. Nauk SSSR; 170: 1407-10(1966). 10p. Dep. CFSTI.

11343 (BNL-tr-297) USE OF PIEZOELECTRIC EFFECT IN ROCKS FOR UNDERGROUND PROSPECTING FOR PIEZOELECTRIC MATERIALS. Volarovich, M. P.; Sobolev, G. A. Translated by Stephen J. Amoretty (Brookhaven National Lab., Upton, N. Y.), from Dokl. Akad. Nauk SSSR; 162: 556-8(1965). 9p. Dep. CFSTI.

11344 (BNL-tr-300) ON THE EXCITATION OF WAVEGUIDES. I. Samarskii, A. A.; Tikhonov, A. N. Translated by S. J. Amoretty (Brookhaven National Lab., Upton, N. Y.), from Zh. Tekh. Fiz.; 17: 1283-96(1947). 26p. Dep. CFSTI.

11345 (BNL-tr-308) EXCITATION OF WAVEGUIDES. II. Samarskii, A. A.; Tikhonov, A. N. Translated by Stephen J. Amoretty (Brookhaven National Lab., Upton, N. Y.), from Zh. Tekh. Fiz.; 17: 1431-40(1947). 18p. Dep. CFSTI.

11346 (BNWL-SA-1698) TECHNIQUES FOR QUALITATIVE AND QUANTITATIVE EVALUATION OF INFRARED IMAGERY. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Feb 1968. 25p. Dep. CFSTI.

Several new techniques for evaluating and displaying infrared scanner data developed and being tested at Battelle-Northwest are described. Although the techniques were developed to evaluate data collected by infrared systems, they appear to have applications to other sequentially scanning, remote-sensing systems. Rapid data-display and evaluation techniques should increase the usefulness of remote sensing systems in geologic, hydrologic, ecologic, meteorologic and other studies. The techniques will aid the interpreter in determining radiation intensity variations and gradients which are often lost in other display methods. New dimensions have been added to scanner data displays by using the radiation intensity as a third dimension and color to discriminate radiation intensity levels. (auth)

11347 (CALT-221-81) ELECTRICAL RESISTIVITY, THERMOELECTRIC POWER AND X-RAY INTERFERENCE FUNCTION OF AMORPHOUS Ni-Pt-P ALLOYS. Sinha, Ashok K. (California Inst. of Tech., Pasadena. W. M. Keck Lab. of Engineering Materials). Dec 1969. Contract AT(04-3)-221. 17p. Dep. CFSTI.

11348 (CALT-767-P-3-7) A STUDY OF DISLOCATION MOBILITY AND DENSITY IN METALLIC CRYSTALS. Annual Summary Report No. 7, Period Ending July 1969. Vreeland, T. Jr.; Wood, David S. (California Inst. of Tech., Pasadena. W. M. Keck Lab. of Engineering Materials). Contract AT(04-3)-767. 9p. Dep. CFSTI.

11349 (COO-958-15) ELECTROCHEMISTRY AND SPECTRA OF METAL-AMMONIA AND METAL-AMINE SOLUTIONS AND KINETICS OF ELECTRON-ATTACHMENT REACTIONS. Technical Progress Report, September 16, 1968-September 15, 1969. (Michigan State Univ., East Lansing). Contract AT(11-1)-958. 14p. Dep. CFSTI.

11350 (COO-1319-78) A STUDY OF THE MECHANISM OF STRESS CORROSION CRACKING IN THE IRON-NICKEL-CHROMIUM ALLOY SYSTEM. Quarterly Report, March 17-June 16, 1968. Staehle, R. W. (Ohio State Univ., Columbus. Dept. of Metallurgical Engineering). 3 Sep 1969. Contract AT(11-1)-1319. 58p. Dep. CFSTI.

11351 (COO-1574-12) AN EXTENSION OF THE LAW OF CORRESPONDING STATES TO RARE-GAS SOLIDS. Pollack, Gerald L. (Michigan State Univ., East Lansing. Dept. of Physics). [1968]. 20p. Dep. CFSTI.

11352 (COO-1580-7) CONTROLLED POLYMERIZATION OF ADSORBED MONOMERS. Technical Progress Report. Livingston, H. K. (Wayne State Univ., Detroit, Mich. Coll. of Liberal Arts). 29 Dec 1969. Contract AT(11-1)-1580. 12p. Dep. CFSTI.

11353 (COO-1580-8) POLYMERIZATION ON CARBON BLACK SURFACES. Livingston, H. K.; Senkus, Raymond; Hsieh, John T.-T. (Wayne State Univ., Detroit, Mich. Dept. of Chemistry). 29 Dec 1969. Contract AT(11-1)-1580. 13p. Dep. CFSTI.

11354 (COO-1616-11) MOESSBAUER STUDIES OF THE TRANSITION ELEMENT HALIDES. Cavanagh, John Francis (Purdue Univ., Lafayette, Ind. Dept. of Physics). Jun 1969. Contract AT(11-1)-1616. 108p. Dep. CFSTI.
Thesis.

11355 (COO-1675-9) KNUDSEN AND MOLECULAR DIFFUSION OF GASES IN CAPILLARIES AND POROUS SOLIDS OVER LARGE PRESSURE RANGES. Technical Progress Report, 1 April 1969-31 March 1970. Geankoplis, Christie J. (Ohio State Univ. Research Foundation, Columbus). 28 Nov 1969. Contract AT(11-1)-1675. 34p. Dep. CFSTI.

11356 (COO-1778-3) A STUDY OF GRAIN BOUNDARY SEGREGATION USING THE AUGER ELECTRON EMISSION TECHNIQUE. Annual Technical Progress Report, II. Stein, D. F.; Joshi, A.; Ramasubramanian, P. V. (Minnesota Univ., Minneapolis. School of Mineral and Metallurgical Engineering). 29 Dec 1969. Contract AT(11-1)-1778. 8p. Dep. CFSTI.

11357 (COO-1783-2) A STUDY OF INTERMEDIARY METABOLISM OF CARBOHYDRATES WITH ISOTOPICALLY LABELED COMPOUNDS. Progress Report. Wood, Harlan G. (Case-Western Reserve Univ., Cleveland, Ohio. Dept. of Biochemistry). 15 Sep 1969. Contract AT(11-1)-1783. 29p. Dep. CFSTI.

11358 (COO-1783-3) A STUDY OF INTERMEDIARY METABOLISM WITH ISOTOPICALLY LABELED COMPOUNDS. Comprehensive Report, September 1966-September 1969. Wood, Harland G. (Case-Western Reserve Univ., Cleveland, Ohio. Dept. of Biochemistry). 15 Sep 1969. Contracts AT(30-1)-1320; AT(11-1)-1783. 21p. Dep. CFSTI.

11359 (COO-1804-12) MICROBIOLOGY OF THERMALLY POLLUTED ENVIRONMENTS. Technical Progress Report, May 1, 1969-April 30, 1970. Brock, Thomas D. (Indiana Univ., Bloomington. Dept. of Microbiology). 10 Nov 1969. Contract AT(11-1)-1804. 18p. Dep. CFSTI.

11360 (COO-2012-1) KINETICS OF THE PUMP-LEAK SYSTEM OF TRANSPORT IN THE OCULAR LENS, DERIVED FROM CLASSIC ENZYME KINETICS AND DIFFUSION THEORY. McLean, Ian; Kinsey, V. Everett (Oakland Univ., Rochester, Mich. Inst. of Biological Sciences); La Force, Richard Conley (Mayo Foundation, Rochester, Minn.). [1969]. Contract AT-(11-1)-2012. 16p. Dep. CFSTI.

11361 (CTC-22) TABLE LOOKUP TECHNIQUES. Price, C. E. (Union Carbide Corp., Oak Ridge, Tenn. Computing Technology Center). 17 Dec 1969. Contract W-7405-eng-26. 44p. Dep. CFSTI.

Consideration is given to basic methodology for table searching in computer programming. Only static tables are treated but references are given to techniques for handling dynamic tables. Methods described are: sequential search, merge search, binary search, estimated entry, and direct entry. The rationale of key transformation is indicated, and methods of "hash addressing" are referenced. A general guide to technique selection is given in conclusion. (auth)

11362 (D-1-82-897) RELATIONSHIP BETWEEN A WIENER-HERMITE EXPANSION AND AN ENERGY CASCADE. Crow, S. C.; Canavan, G. H. (Boeing Scientific Research Labs., Seattle, Wash. Flight Sciences Lab.). Aug 1969. 36p. Dep. CFSTI.

11363 (EGG-1183-465) FILM CHARACTERISTIC CURVES (PLOTTED AGAINST ABSOLUTE ENERGY AT WAVELENGTHS 4280A, 5250A, 5780A, 6115A). Technical Report Number B-3871.

Bunker, F. J.; Burke, M. A.; Greenberg, H. M.; Guenette, J. G. (EG and G, Inc., Bedford, Mass. Eastern Science and Technology Div.). 18 Jul 1969. Contract AT(29-1)-1183. 40p. Dep. CFSTI.

11364 (EURAEC-2082) THE RELATIONSHIP OF NITROGEN CONTENT OF AUSTENITIC STAINLESS STEELS TO STRESS CORROSION. Quarterly Report No. 438-18. Clevinger, Gary S. (Virginia Polytechnic Inst., Blacksburg. Dept. of Metals and Ceramic Engineering). Jan 1969. Contract AT(40-1)-3208. 42p. Dep. CFSTI.

Work performed under United States-Euratom Joint Research and Development Program.

Research directed toward determination of the relations of N content in austenitic stainless steels with their susceptibility to stress corrosion is reported. Results of experiments on low temperature diffusion of interstitials in Type 304 stainless steel are presented along with those on aging of this steel at 200°C. (J.R.D.)

11365 (EURAEC-2099) THE RELATIONSHIP OF NITROGEN CONTENT OF AUSTENITIC STAINLESS STEELS TO STRESS CORROSION. Quarterly Report No. 438-19. Clevinger, Gary S. (Virginia Polytechnic Inst., Blacksburg. Dept. of Metals and Ceramic Engineering). Apr 1969. Contract AT(40-1)-3208. 20p. Dep. CFSTI.

Work performed under United States-Euratom Joint Research and Development Program.

Efforts to determine the effects of nitrogen content on stress corrosion of stainless steels are described. Results of work on the effects of aging temperature on corrosion susceptibility of Type 304 stainless steel are reported along with efforts devoted to preparation of specimens for electron microscopy. (J.R.D.)

11366 (EURAEC-2126) WORK CARRIED OUT AT THE UNIVERSITY OF GHENT UP TO 30th JUNE 1969. Topical Report No. 2. (Ghent Rijksuniversiteit (Belgium). Laboratorium voor Weerstand van Materialen). 22 Sep 1969. Contract 081-67-1-TEEC(RD). 11p. (EUR-4019). Dep. CFSTI.

Work performed under United States-Euratom Joint Research and Development Program.

11367 (IS-2079) THE PROGRAM LOGIC OF SASSEM, A SYMBOL ASSEMBLER. Covert, George (Ames Lab., Iowa). Nov 1968. Contract W-7405-eng-82. 77p. Dep. CFSTI.

SASSEM is a two pass assembler which accepts source statements written in the SDS SYMBOL language for a SDS 910 computer and produces a listing and object decks that can be loaded and executed by the standard SDS 910 loaders. SASSEM presently runs on an IBM 360/65 under OS/MVT and is written entirely in PL/1. It requires 128K region and assembles at the rate of 1100 to 1300 cards per minute of central processing unit time. The program logic of SASSEM is discussed. (auth)

11368 (LA-4322) STIFF: COMPUTER PROGRAM FOR THE SOLUTION OF STEADY, TURBULENT, INCOMPRESSIBLE FLUID FLOWS IN TWO DIMENSIONS. Ziemniak, Stephen E. (Los Alamos Scientific Lab., N. Mex.). 17 Nov 1969. Contract W-7405-eng-36. 19p. Dep. CFSTI.

11369 (NUMEC-3292-15) DETERMINATION OF THE RHOMBIC TO CUBIC TRANSITION TEMPERATURES OF THE ALKALI METAL TETRAFLUOROBORATES USING DIFFERENTIAL THERMAL ANALYSIS. Marano, R. T.; Shuster, E. R. (Nuclear Materials and Equipment Corp., Lewiston, N. Y. Niagara Div.). 9 Dec 1969. Contract AT(40-1)-3292. 18p. Dep. CFSTI.

11370 (NVO-99-10) REPORT ON STRUCTURAL DAMAGE IN LUMBERTON AND DULCE, NEW MEXICO CAUSED BY THE EARTHQUAKE OF JANUARY 22, 1966. (Blume (John A.) and Associates Research Div., San Francisco, Calif.). Mar 1966. Contract AT(26-1)-99. 85p. Dep. CFSTI.

11371 (NYO-1447-57) SPECTRA AND ZEEMAN EFFECTS OF RUBY SINGLE CRYSTALS AT LOW TEMPERATURES. Spectroscopic Report No. 24. Jacobs, Stephen F. (Johns Hopkins Univ., Baltimore, Md. Dept. of Physics). Jan 1969. Contract AT(30-1)-1447. 78p. Dep. CFSTI.

11372 (NYO-1710-96) A PRELIMINARY STUDY OF THE EXCHANGE OF C ATOMS BETWEEN CO AND GRAPHON. Phillips, Roger; Vastola, F. J.; Walker, P. L. Jr. (Pennsylvania State Univ., University Park. Dept. of Materials Science). Nov 1969. Contract AT(30-1)-1710. 23p. Dep. CFSTI.

11373 (NYO-2394-37) AN EXPERIMENTAL STUDY OF THE STRENGTH OF CAST ALUMINUM-SILICON ALLOYS. Technical Report No. 37. Erginer, E.; Gurland, J. (Brown Univ., Providence, R. I. Div. of Engineering). Sep 1969. Contract AT(30-1)-2394. 34p. Dep. CFSTI.

11374 (NYO-2504-70) ELASTIC AND PLASTIC DEFORMATION OF SOLIDS. Annual Progress Report, February 1, 1969-January 31, 1970. Ruoff, Arthur L. (Cornell Univ., Ithaca, N. Y. Dept. of Materials Science and Engineering). 22 Sep 1969. Contract AT(30-1)-2504. 12p. Dep. CFSTI.

11375 (NYO-3401-6) ENERGY TRANSFER IN CHEMICAL AND BIOLOGICAL SYSTEMS. Period Covered: 1964-1969. Lee, John (Georgia Univ., Athens. Dept. of Biochemistry). Contract AT(30-1)-3401. 12p. Dep. CFSTI.

11376 (NYO-3823-5) INTERNAL FIELD OF Sc IN A Ni HOST. Technical Repqrt I. Hohenemser, C.; Reno, R.; Benski, H. C. (Brandeis Univ., Waltham, Mass. Dept. of Physics). 31 Oct 1969. Contract AT(30-1)-3823. 31p. (CONF-700102-1). Dep. CFSTI.

From Annual Meeting of the American Physical Society, Chicago, Ill.

11377 (NYO-3823-6) INTERNAL FIELD OF Rh IN A Ni HOST NEAR THE CURIE POINT. Technical Report II. Hohenemser, C.; Reno, R. (Brandeis Univ., Waltham, Mass. Dept. of Physics). 31 Oct 1969. Contract AT(30-1)-3823. 14p. (CONF-700102-2). Dep. CFSTI.

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11378 (NYO-3827-11) ANNUAL PROGRESS REPORT [ON BIOMEDICAL RESEARCH], MARCH 1, 1969-FEBRUARY 28, 1970. Hymer, Wesley C. (Pennsylvania State Univ., University Park. Dept. of Biology). 5 Dec 1969. Contract AT-(30-1)-3827. 32p. Dep. CFSTI.

11379 (NYO-3991-3) HIGHER ORDER ELASTIC CONSTANTS AND ANHARMONIC PROPERTIES OF CUBIC CRYSTALS WITH APPLICATION TO NaI, KI, AND VITREOUS SILICA. Shull, H. Eugene (Pennsylvania State Univ., University Park. Dept. of Engineering Mechanics). Dec 1969. 220p. Dep. CFSTI.

Thesis.

11380 (ORNL-HUD-1) EXAMINATION OF HIGH PRESSURE WATER JETS FOR USE IN ROCK TUNNEL EXCAVATION. McClain, W. C.; Cristy, G. A. (Oak Ridge National Lab., Tenn.). Jan 1970. Contract W-7405-eng-26. 53p. Dep. CFSTI.

11381 (ORNL-TM-2796) TESTS OF THE LUWA BLAST VALVE. Chester, Conrad V. (Oak Ridge National Lab., Tenn.). 10 Dec 1969. 19p. Dep. CFSTI.

11382 (ORNL-tr-2209) CHARACTERIZATION OF CARBONS AND GRAPHITES THROUGH ANALYSIS OF THE (001) X-RAY INTERFERENCE. Christu, N.; Fitzer, E.; Fritz, W.; Overhoff, D. Translated by Dudley M. Hewette II, O. B. Cavin, and Sigfred Peterson (Oak Ridge National Lab., Tenn.), from Carbon; 7: 397-411(1969). 20p. Dep. CFSTI.

11383 (ORNL-tr-2210) REPARTITION FUNCTIONS OF A POLYNOMIAL REPARTITION. Stoka, Marius I. Translated by Francois Kertesz (Oak Ridge National Lab., Tenn.), from Stud. Cercet. Mat.; 18: 1281-5(1966). 5p. Dep. CFSTI.

11384 (ORNL-tr-2245) ON THE DETERMINATION OF NOZZLE PERFORMANCE OF A HYDRAULIC MINING DEVICE. Yoshizawa, Yukio; Kawashima, Toshio; Yanaida, Katuya. Translated for Oak Ridge National Lab., Tenn., from Nippon Kogyo Kaishi; 81: 29-34(1965). 14p. Dep. CFSTI.

11385 (ORNL-tr-2256) ALUMINUM HYDROXIDES AND OXIDES: THEIR PREPARATION AND PROPERTIES. Fiedorow, Ryszard. Translated for Oak Ridge National Lab., Tenn., from Wiad. Chem.; 21: 761-70(1967). 16p. Dep. CFSTI.

11386 (ORNL-tr-2264) PREPARATION OF VERY PURE, FINELY DIVIDED ALUMINUM OXIDE FROM TRIETHYLALUMINUM. Thiele, K. H.; Schwartz, W.; Dettmann, L. Translated by R. Gregg Mansfield (Oak Ridge National Lab., Tenn.), from Z. Anorg. Allg. Chem.; 349: 324-7(1967). 5p. Dep. CFSTI.

Triethylaluminum yields on combustion in an O_2/H_2 flame a very pure aluminum oxide. On heating for a short time at about 1200°C this aluminum oxide can be transformed to α-Al_2O_3, the particles of which have a spherical shape with diameters between 0.02 and 0.2 μm. (auth)

11387 (ORO-2036-12) PROGRESS REPORT [ON SOLID-STATE STUDIES], DECEMBER 16, 1968-DECEMBER 15, 1969. Slifkin, Lawrence; Batra, Anand (North Carolina Univ., Chapel Hill. Dept. of Physics). [1970]. Contract AT(40-1)-2036. 6p. Dep. CFSTI.

11388 (SC-CR-68-3651) EXPLODING BRIDGEWIRE DETONATOR CIRCUIT CALCULATIONS. (Stanford Research Inst., Menlo Park, Calif.). [1968]. 5p. Dep. CFSTI.

Results of an exploding bridgewire detonator investigation conducted by Stanford Research Institute for Sandia Corporation are reported. The investigation has yielded a better functional model for an EBW detonator for use in computer simulation of any firing set. When used in an appropriate digital computer program the detonator model will enable the engineer to examine the firing characteristics of any firing set configuration at minimum expense and with fewer experiments than has been possible in the past. (auth)

11389 (SC-DC-69-1976) SOME OBSERVATIONS ON THE INFLUENCE OF GRAPHITE MICROSTRUCTURE ON ABLATION PERFORMANCE. McVey, D. F.; Auerbach, I.; McBride, D. D. (Sandia Labs., Albuquerque, N. Mex.). [1969]. 19p. (CONF-700103-1). Dep. CFSTI.

From 8th Aerospace Meeting, New York.

11390 (SC-DR-69-530) CARBON COMPOSITES FROM WOOL FELT SUBSTRATES. Pierson, H. O.; Smatana, J. F. (Sandia Labs., Albuquerque, N. Mex.). Sep 1969. 20p. Dep. CFSTI.

The development of carbon composites obtained by chemical vapor deposition of carbon on a carbonized wool substrate is described, as well as the study of the carbonization of wool, the deposition parameters, and the effects of high temperature heat treatment. The mechanical, thermal, and ablation properties of these composites are described. These composites showed a substantial increase in strength over conventional rayon felt based composites prepared under the same infiltration conditions. (auth)

11391 (SC-DR-69-709) CARBON-LUCITE ABSORBER SYSTEMS FOR LASER MATERIAL STUDIES. Anderholm, N. Curtis; Anderson, Philip D. (Sandia Labs., Albuquerque, N. Mex.). Dec 1969. 16p. Dep. CFSTI.

11392 (SC-DR-69-782) TERRADYNAMIC RESULTS AND STRUCTURAL PERFORMANCE OF A 650-POUND PENETRATOR IMPACTING AT 2,570 FEET PER SECOND. Patterson, W. J. (Sandia Labs., Albuquerque, N. Mex.). Dec 1969. 29p. Dep. CFSTI.

11393 (SC-RR-69-446) DIGITAL COMPUTER SOLUTION OF LAPLACE'S EQUATION INCLUDING DIELECTRIC SURFACES. Boers, Jack E. (Sandia Labs., Albuquerque, N. Mex.). Dec 1969. 67p. Dep. CFSTI.

11394 (SC-RR-69-577) AN EXPERIMENTAL INVESTIGATION OF THE FLOW FIELD AROUND AN INCLINED SHARP CONE IN HYPERSONIC FLOW. George, Oscar L. Jr. (Sandia Labs., Albuquerque, N. Mex.). Sep 1969. 74p. Dep. CFSTI.

11395 (SC-RR-69-728) ONE-DIMENSION LAGRANGIAN HYDRODYNAMICS AND THE IDLH HYDROCODE. Hicks, Darrell Lee (Sandia Labs., Albuquerque, N. Mex.). Dec 1969. 68p. Dep. CFSTI.

11396 (SC-T-69-1060) INFLUENCE OF THE DIFFRACTION OF CERTAIN PERFECTLY CONDUCTED OBSTACLES ON THE PRECISION OF THE GONIOMETRY OF ELECTROMAGNETIC EMISSIONS. Dubost, G. Translated by Marcel I. Weinreich (Sandia Labs., Albuquerque, N. Mex.), from Ann. Radioelec.; 22: No. 90, 368-86(1967). 34p. Dep. CFSTI.

11397 (SC-T-70-4000) CERTAIN PROPERTIES OF MOLTEN (LIQUID) ALUMINUM OXIDE. Zubarev, U. V.; (and others). Translated by Marcel I. Weinreich (Sandia Labs., Albuquerque, N. Mex.), from Izv. Akad. Nauk SSSR, Neorg. Mater.; 5: 1563-5(1969). 6p. Dep. CFSTI.

11398 (SC-T-70-4003) METHOD OF FORMULATING THE BOUNDARY CONDITIONS IN PROBLEMS OF VISCOUS FLUID FLOW. Varzhanskaia, T. S. Translated by Marcel I. Weinreich (Sandia Labs., Albuquerque, N. Mex.), from Izv. Akad. Nauk SSSR, Mekh. Zhidk. Gaza; No. 3, 142-4(1963). 6p. Dep. CFSTI.

11399 (SC-T-70-4004) INFLUENCE OF CARBON ON THE CURIE TEMPERATURE AND THE SPONTANEOUS MAGNETIZATION IN NiFe ALLOYS WITH 20 PERCENT TO 50 PERCENT Ni. Adler, E.; Radeloff, C. Translated by Marcel I. Weinreich (Sandia Labs., Albuquerque, N. Mex.), from Z. Angew. Phys.; 26: 105-13(1969). 22p. Dep. CFSTI.

11400 (TID-4579(3rd Ed.)) SERIAL TITLES CITED IN NUCLEAR SCIENCE ABSTRACTS. (Division of Technical Information Extension (AEC), Oak Ridge, Tenn.). Jan 1970. 378p. Dep. CFSTI.

11401 (TID-25309) POSITRON ANNIHILATION IN POLYMERS OF VARIOUS MOLECULAR WEIGHTS. Tao, S. J.; Chuang, S. Y. (New England Inst. [for Medical Research], Ridgefield, Conn.). Jun 1969. Contract AT(30-1)-3661. 16p. Dep. CFSTI.

11402 (UCLA-34-P-8-X-2) AN APPROACH TOWARDS DEFINING THE ROLE OF CHLOROPLAST DNA IN THE REPRODUCTION AND DIFFERENTIATION OF CHLOROPLASTS OF HIGHER PLANTS. Wildman, S. G. (California Univ., Los Angeles). [1969]. 19p. Dep. CFSTI.

11403 (UCLA-34-P-8-X-3) EFFECT OF TMV MULTIPLICATION ON RNA AND PROTEIN SYNTHESIS IN TOBACCO CHLOROPLASTS. Hirai, Atsushi; Wildman, S. G. (California Univ., Los Angeles). [1968]. Contract AT(11-1)-34. 25p. Dep. CFSTI.

11404 (UCRL-7873(Pt.3)) SOME ANALYTICAL METHODS FOR EXPLOSIVES. PART III. Selig, Walter (California Univ., Livermore. Lawrence Radiation Lab.). Sep 1969. 56p. Dep. CFSTI.

Yamamura's indirect complexometric method for the determination of macro amounts of fluoride was adapted to the analysis of organic samples after combustion in an oxygen bomb. It was used for determination of FEFO in plastic-bonded explosives. (auth)

11405 (UCRL-19075) STRUCTURE AND MECHANICAL PROPERTIES OF Fe-Ni-Mn-C STEELS. Huang, Der-Hung (California Univ., Berkeley. Lawrence Radiation Lab.). Sep 1969. Contract W-7405-eng-48. 96p. Dep. CFSTI.

Thesis.

11406 (UCRL-50729) FORTRAN CODE FOR ANALYSIS OF OPTICAL ROTATORY DISPERSION DATA. Martin, Walter H. Jr. (California Univ., Livermore. Lawrence Radiation Lab.). Aug. 8, 1969. 10p. Dep. CFSTI.

A Fortran code has been developed for the processing of optical rotatory dispersion data from a spectropolarimeter. The program is designed to run under the Monitor system of the CDC 6600 computer. It applies the Moffitt equation to derive the constants describing helical content and helical conformation, and thus provides a way to follow transitions in solution of proteins and polypeptides. (auth)

11407 (UCRL-Trans-10414) OSCILLOPOLAROGRAPHY OF EXPLOSIVE NITRO DERIVATIVES. Riganti, V.; Locchi, S.; Curti, R. Translated by Z. St-Gallay for Univ. of California, Lawrence Radiation Lab., Livermore, from Rass. Chim.; 21: 3-8(1969). 16p. Dep. CFSTI.

11408 (UCRL-Trans-10416) STRUCTURE OF AN ORDERED ALLOY OF COMPOSITION NEAR Au_3Cu. Okuzumi, H.; Perio, P.; Tournarie, M. Translated for Univ. of California, Lawrence Radiation Lab., Livermore, from Acta Crystallogr.; 12: 1039(1959). 10p. Dep. CFSTI.

11409 (UCRL-Trans-10419) EFFECT OF CHARGE SHAPE ON THE DETONATION PARAMETERS OF AMMONITE PZhV-20. Dremin, A. N.; Shvedov, K. K.; Klapovskii, V. S. Translated by J. Mulhaus for Lawrence Radiation Lab., Livermore, Calif., from Vzryvnoe Delo, Nauch.-Tekh. Gorn. Obshchest., Sb.; No. 63/20, 129-35(1967). 12p. Dep. CFSTI.

11410 (Y-1701) EXPERIMENTAL AND THEORETICAL DETERMINATION OF RESIDUAL STRESSES IN FILAMENT-WOUND RINGS. Dewey, B. R.; Knight, C. E. Jr. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). 6 Jan 1970. Contract W-7405-eng-26. 45p. Dep. CFSTI.

11411 (Y-1704) ULTRAVIOLET SPECTROPHOTOMETRIC DETERMINATION OF ISOTRUXENE IN AUTOCLAVE-PRODUCED INDENE POLYMERS. Williams, N. J. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). 13 Jan 1970. Contract W-7405-eng-26. 14p. Dep. CFSTI.

A spectrophotometric method was developed for determining the content of isotruxene in truxene-isotruxene mixtures produced by the autoclave polymerization of indene. The accuracy

of the method is not precisely known due to the uncertainty of the impurity level in the isotruxene standard; however, it is estimated to be ±3.4 percent absolute assuming the purity of the isotruxene is 97 ± 2 percent absolute. (auth)

11412 PLUTONIUM-DOKUMENTATION. Referate-Zeitschrift mit Anhang Transplutonium-Elemente. October 1969. Band 3, Heft 10. 230 Referate (Register-Nr. 3175-3753). (Plutonium-Documentation. Abstract Journal with Appendix on Transplutonium Elements. October 1969. Vol. 3, No. 10. 230 Abstracts (Register No. 3175-3753)). Karlsruhe, Ger., Gesellschaft fuer Kernforschung m. b. H., 1969. 157p. (In German and English).

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